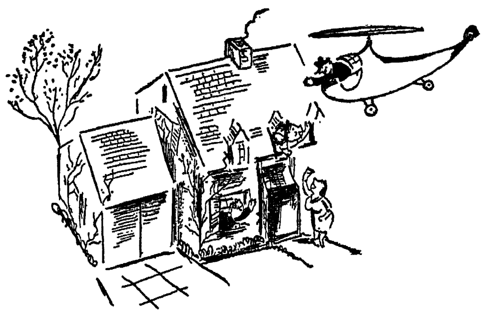
C. B. F. MACAULEY

The HELICOPTERS ARE COMING



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To

CALLCOTE

FOREWORD

SO, the helicopters are coming? But when? That is what everybody wants to know. Since I possess no mystical powers which enable me to foresee the future with exact certainty, I cannot tell you—nor can anyone else.

In this book, which is the first complete work ever devoted to the subject of helicopters, I have attempted to set forth the facts, plainly labeled as such, so that every reader can form independent conclusions based on a factual foundation.

Beyond that, I have freely expressed my own opinions regarding the future possibilities of the helicopter and how it might serve us usefully in private and commercial activities. My opinions are based on personal experience, on the expressed convictions of men who are even better qualified to estimate its future, and on information which cannot be published yet for reasons of military security.

It will be obvious, after reading what follows, that the helicopters now flying would not be suitable for the average private owner. The cost would be more than we pay for a good home. Considerable skill would have to be exercised to coordinate the controls. Maintenance

costs would be prohibitive for the average person. There are mechanical "bugs" which must be worked out by painstaking effort on the part of designers and engineers.

Some of the pessimists who feel it their duty to warn the public against anticipating practical helicopters for a decade or two compare helicopters at their present stage of development with the automobiles of 35 years ago and airplanes of 25 years ago, and intimate that a similar amount of time will elapse before the helicopter "arrives" for every man.

That is just plain silly. The most important element of highway or air transportation is a suitable package of power. The automobile was not successful until satisfactory engines were developed; efficient flight had to await the development of still better engines.

The helicopter has available highly perfected, light, reliable engines of a great variety of designs. The aerodynamic problems are but an extension of the years of research already accomplished on airfoils, propellers, and streamlined bodies.

The helicopter is not starting from scratch. It is an offshoot of the airplane, somewhat as a jeep is an offshoot of the automobile. It did not take 30 or 40 years to develop a jeep—it took less than 30 months—and any engineer will tell you it is quite a different vehicle. The basic solutions to problems which previously stood in the way of safe and efficient helicopter flight have been worked out. From there on it is a matter of improving,

refining, and simplifying. This is going on at a rapid pace. Money, engineering brains, mechanical genius, and production facilities now being devoted to the "refining" of helicopters are on a scale so far beyond those afforded cars and airplanes in their earliest years that no comparison is possible.

In other words, you will not be able to go down to the Main Street showrooms and pick out your helicopters as soon as the war ends. But the first few helicopters may be offered for sale before the end of the following year, perhaps a little longer. The first models may be more expensive than a medium-priced car and will certainly require more care and expense in upkeep.

The ability of the helicopter to go places and do things impossible for cars or airplanes, however, will more than offset its initial economic disadvantages. From there on, a steady decrease in purchase cost and upkeep, coupled with continued improvement in performance, will constantly widen the market for this amazingly versatile new vehicle.

It is my sincere wish that this book will serve the cause of sound development and utilization of helicopters by answering fairly the questions in the minds of everyone regarding the highly controversial subject of the helicopter's future. I do not think it will lead anyone to expect too much too soon. On the other hand, I hope

it will help to stimulate interest in the many ways the helicopter can surely serve us in recreation, travel, and daily work as it comes of age in the years ahead.

For example, I think some consideration of the helicopter's probable future might very well enter into the selection of a home site or a summer camp. This is already the case with me and with many of my friends. Community leaders and planners will be delinquent in the fulfillment of their responsibilities if they exclude it from their thinking. Industrialists, merchants, real estate men, and many others whose duties dictate an interest in future trends must necessarily study the social implications of this new form of transportation.

To Igor I. Sikorsky, engineering manager of the Sikorsky helicopter division of United Aircraft Corporation, I wish to make grateful acknowledgment for his criticisms and suggestions concerning portions of the manuscript. C. L. Morris, Sikorsky's helicopter test pilot, graciously permitted me to draw upon his own colorful descriptions of helicopter flying for a portion of this book.

Aviation writers who helped me through their counsel or published works included Leighton Collins, E. Eugene Miller, S. Paul Johnston and Henry W. Roberts.

C. Douglas Stengel, of General Motors Corporation; Enea Bossi, of Higgins Industries, Inc.; Bill Williams, of

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C. B. F. M.

January, 1944.

CONTENTS

ILLUSTRATIONS

CHAPTER I

WHAT IS A HELICOPTER?

THAT utterly fantastic, absurdly improbable mechanical contraption, the helicopter, is at last a practical reality. It is going to change your life more than you think in the years to come. Through the exigencies of war, this thing which has been the plaything of inventors for centuries is suddenly thrown amongst us in great numbers; a brand new transportation vehicle.

Up to 1943, the helicopters made in the United States could be numbered on your hands. Of the many contenders in the field at that late date, only one could point to a practical helicopter design successfully proved through hundreds of flights dating back to 1939.

That one, most successful to date, is manufactured by the Sikorsky Aircraft Division of United Aircraft Corporation. The designer is Igor I. Sikorsky, who prior to his successful experiments with the helicopter was famed the world over as the designer and builder of reliable and efficient multiengine flying boats and amphibians for over-ocean travel.

The helicopter emerges from World War II some-

what like the airplane emerged from World War I—engineering and development accelerated, performance greatly stepped up and an important role in the transport of the world's commerce and peoples assured.

The operational experience being piled up by helicopters of the military and naval forces of the United States, plus the establishment of considerable facilities for their production, will bring forth a safe, reasonably economical, small-family-sized helicopter within reach of middle-class incomes much sooner than most people realize.

Like any new invention or technique which becomes a part of our everyday life, the advent of the helicopter for all brings a host of new words and phrases to our daily speech. Who knows but that "motoring" will find an aeronautical counterpart in "whirling" to town, or "'coptering"?

The fixed-wing aircraft manufacturers are trying to make the term "aircar" stick for light family planes. But think of the interesting possibilities of "helicar," "helicab," "helibus," et cet., for the various types of helicopters.

At this stage of development, the diversity of helicopter designs, actual and experimental, probably is greater by far than was the case in the early days of the "horseless carriage." It is not to be wondered at if some of the words concerning helicopters are strange or confusing to the layman. Hence, a few explanations and

definitions, while something less than dramatic, will smooth your way through the pages to follow.

In the heavier-than-air category there are two main classifications of aircraft. First, the fixed-wing group, which comprises all of our conventional transports, bombers, fighters and so on of the present day, and, second, the rotary-wing group. The two chief kinds of rotary-wing aircraft are autogiros and helicopters.

The *autogiro* has an engine and propeller in the nose (like any conventional single-engine airplane) which propels it forward. The forward speed along the ground or in the air causes the paddle blades of the overhead rotor to whirl by virtue of the aerodynamic forces set up by the action of the air stream against the blades of the rotor. This action is called autorotation, hence the term autogiro.

The *helicopter* has a suitable engine geared directly to a vertical shaft (or shafts) which drives a similar set of lifting blades rotating in a horizontal plane. As the speed of rotation increases, the helicopter rises directly upwards. Then it can be moved forward, to the right, left, or reversed by tilting the direction of lift.

Somewhat different types of rotary-wing aircraft are termed *giroplanes* and *cyclogiros*. They are in earlier stages of development than helicopters or autogiros.

There are still other hybrids, such as the *convertaplane*, which consists of one fixed wing and a secondary

wing which revolves around a vertical axis for take-off and landing, but can be brought to a standstill in mid-air to lessen resistance and accomplish swifter forward flight.

It would be a rash man, be he engineer or prophet, who would ridicule or belittle any of these types, for these contraptions are but embryos yet and we cannot foretell what they may be like in maturity—any more than the Wright brothers could foresee the transocean Clippers and deadly super-bombers of today.

The foregoing is of course necessarily oversimplified. For example, the autogiro may have a clutch arrangement which imparts mechanical rotation to the main rotor before the take-off. This has the effect of shortening the take-off run. Thus the autogiro assumes some of the characteristics of the helicopter. Or again, the helicopter may have more than one rotor, or dual sets of blades rotating in opposite directions about the same vertical axis.

Moreover, there is not entire agreement on terms and definitions among the experts. Mr. Harold F. Pitcairn, President of the Autogiro Company of America, makes the point that the terms autogiro and helicopter, in view of today's designs, are no longer descriptive of completely different types of aircraft. He states:

"No sharp line of distinction can be drawn, because the modern helicopter largely incorporates the fundamentals of the autogiro as originated by the late Juan

de la Cierva and developed by the Autogiro Company of America. Modern helicopters employ the autogiro type of rotor. They use the autogiro control system. If the engine fails, the helicopter uses the autorotation of the autogiro to effect a landing, which is an imperative safety provision."

Mr. Pitcairn argues that the development of the helicopter has come about primarily by the application of power to the autogiro rotor during flight plus the provision of a means for balancing the torque. He maintains that if the autogiro rotor were driven by the engine while the machine was in the air, giving it the ability to hover, it might also be considered a helicopter.

Many doubtless would disagree with Pitcairn, maintaining that if the helicopter uses a rotor or other principle similar to the autogiro, it is pure coincidence without affecting the fundamentally different concept embodied in the term. But all scientific, legal or etymological quibbling over terminology will be so much time wasted because the ultimate decision will be handed down by the American public. It may be helicar, girocar, plain giro or sky buggy: no weighty pronouncements by learned societies or individuals will influence the course of our colorful American "slanguage!"

Naturally everybody wants to know how difficult it is to fly a helicopter. If it takes months or years of study and training, a lot of persons simply would not be in-

terested. They would stick to their automobiles and only ride in commercial helicopters where the operation was taken care of by the pilot. If it is as easy to fly a helicopter as it is to drive an automobile, then there is no problem. But it is impossible to say that so many hours of instruction will prepare a person for safe operation of a helicopter—just as impossible as it is to specify a certain minimum number of hours for instruction of any individual in highway driving.

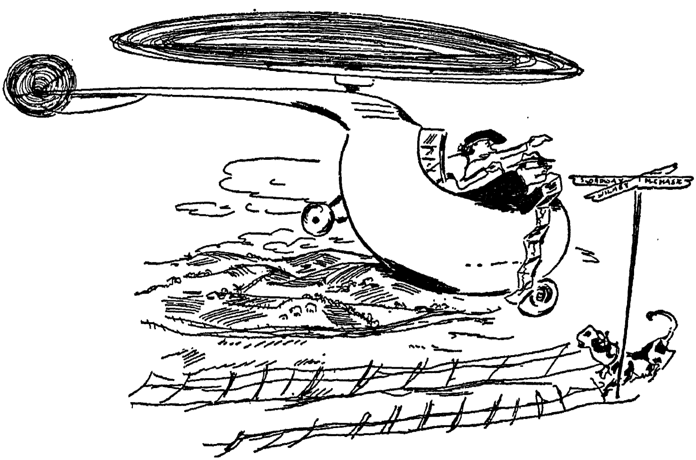
Mr. Sikorsky and his helicopter test pilot, C. L. "Les" Morris, who probably have flown helicopters more hours than any other human beings, have said: "As a general statement, it is reasonable to say that the average person will be able to learn to fly a helicopter proficiently as easily as that same person could learn to drive an automobile."

They qualify that statement somewhat by pointing out that it presupposes the same familiarity with the vehicle and its environment which the average American has with respect to the automobile even before he learns to drive. Thus for many persons without a background of interest or experience in aviation, the period of indoctrination into an entirely new element might be somewhat longer.

Requirements for owning and operating helicopters very properly should be more carefully established than those for driving automobiles. Not because helicopters

are inherently more dangerous or difficult to operate, but because greater potential hazards to the lives and property of others are implicit in aerial navigation than in highway travel.

It does not follow that higher standards need restrict the utility or the acceptance of helicopters. Lower insur-



ance costs and public confidence will more than offset limitations imposed by rigid safety requirements.

There is nothing basically wrong with the present-day helicopter which must be corrected to make it a safe and practical flying machine for private owners. This does not mean that present models would be suitable for mass consumer markets. Further refinements of design and structure must be worked out. That neces-

sary refinements will be satisfactorily accomplished within a couple of years is no longer in doubt.

The top speed of current models is in the neighborhood of 100 miles an hour and this soon will be increased to 140-150 miles per hour on the basis of already existing knowledge. Two-place helicopters powered by 100-horsepower engines will cruise at around 100 miles an hour and get about 10 miles to the gallon of fuel. It is highly probable that gasoline mileage will be much better than this figure in view of the tremendous improvements in motor fuels since the start of the war.

U. S. Army Air Forces Sikorsky helicopter hovers 30 feet above the ground while a passenger comes aboard by means of rope ladder. (*Aviation photo*)

(Facing page

CHAPTER II

THE HELICOPTER COMES OF AGE

ON MAY 13, 1942, in a little meadow near the old Sikorsky airplane factory in Stratford, Connecticut, a new chapter in aviation history was begun. It was reminiscent of the Wright brothers' first airplane flight at Kitty Hawk, nearly forty years earlier, in that there was no fanfare or public ceremony to dedicate the passing of another milestone in the progress of human flight.

On the tree-bordered field there squatted the XR-4, the U. S. Army Air Forces' first successful helicopter—a flying machine without wings. All was in readiness for the start of the first cross-country helicopter flight in the Western Hemisphere. C. L. "Les" Morris, engineering test pilot for Igor Sikorsky, designer and builder of the craft, sat in the cabin at the controls, ready to begin the world's first delivery flight of a helicopter. His destination was Wright Field, Ohio.

The pilot was pleased with his weather. The morning was clear and warm and the gentle spring breeze scarcely rustled the leaves on the near-by elms. A group of engineers and workers from the plant were gathered

by the road. While the pilot studied his instruments and arranged his maps, several of his friends drifted out of the knot of spectators to shake his hand and wish him well.

The engine purred smoothly and the big rotor blades were whirling rhythmically overhead.

Just before time for the take-off, a solitary figure, whose twinkling eyes and nervous movements betrayed his excitement over the event, hurried across the field to the helicopter. Sikorsky thrust his hand through the open window and said, "Well, Les, today you are making history!"

Morris grinned confidently and waved good-by as he increased the power. The engine noise increased to a roar; he pulled up on the control which raised the helicopter straight up into the air. At about 15 feet he eased forward on the stick and started across the field. He circled low over the upturned faces and waving hands, then climbed easily to 1500 feet.

On this first flight of its kind the helicopter was to be paced by a ground escort. An automobile with a large yellow dot painted on its hood was already starting out of the factory gate. In the car were Bob Labensky, the project engineer who had cast his lot with penniless Sikorsky nineteen years ago; Ralph Alex, his assistant, who had labored endless days and nights to bring this craft to flying condition; Adolph Plenefisch, shop foreman who had all but lived with the Sikorsky helicopter

since the first nerve-racking flight in 1939; and Ed Beatty, transportation chief, who had elected himself to be the driver.

Morris soon lost sight of his escort car in the elm-shaded streets of Stratford, but his maps were marked with the exact route they were to take, so he followed it closely, always ready to land in some little field beside the road should the slightest thing go wrong. The ground crew would then see the helicopter as they drove by and delays would be minimized.

The helicopter headed westward at a cruising speed of 60 miles per hour. Altitude was increased to 2000 feet as the ground rose toward the hills.

The first scheduled stop was at New Hackensack on the Hudson River. A mechanic was waiting at the airport and gave the ship a thorough going-over as soon as Morris landed. The ground party had telephoned the New Hackensack airport only a few moments earlier and the highway party had progressed only a little over half the distance covered by the helicopter in spite of the fact that it had flown into head winds all the way.

Even on this uneventful first leg, an unofficial distance record for the Western Hemisphere was established, although Morris was destined to do much better before the trip was completed. In the same helicopter a few weeks earlier, he had attained a speed of 82 miles per hour and climbed to an altitude of 5000 feet.

A complete inspection showed the craft to be as sound

as when it started, so Morris took off again, headed up the valley to Albany. When he reached the Albany airport he chose to land at the end of a line of parked airplanes almost against the boundary fence—a feat which could not be considered with any conventional aircraft. People rushed from hangars and buildings expecting to find wreckage strewn all over the adjacent parking lots. But the landing was made, as Les described it, "without incident." As he got out and walked toward the hangars, someone in the crowd grinned and yelled, "What are you trying to do, scare the hell out of us?"

Another airline distance record was established on this leg—78 miles.

From Albany the route lay westward to Utica, New York. Morris flew low up the Mohawk Valley, often with the hills rising higher than the ship on either side. All along the way, Morris reported that astonished humans gaped skyward at his strange-looking flying windmill.

At the Utica airport the helicopter flew up to the hangar sideways and hung in mid-air for a minute or so, while mouths opened wide enough to land in, then slithered over to the ramp and squatted down.

An airport guard strolled over and remarked casually, "I don't believe what I just saw. Of course I realize this is a secret ship, but will it be all right if I look again when you take off?"

Again he had broken existing records. On this leg he

remained in the air 1 hour and 55 minutes, which was 20 minutes longer than the existing endurance record held by Sikorsky. Also, the distance covered was four miles greater than the previous leg.

The day's last stretch, from Utica to Syracuse, was flown in the late afternoon. On this part of the trip, excessive oil temperature caused the pilot considerable worry, but the air was smooth and a gentle tail wind put him into Syracuse 15 minutes ahead of schedule.

Still another airport attendant was to be startled out of his wits that day. A guard who had been instructed to show the incoming aircraft where to park came around the corner of a hangar to find the flyer poised 15 feet in the air waiting for directions. After recovering from the initial shock, he pointed down the field and started off at a dog trot with the helicopter following at his heels like an overgrown pet.

The first day had gone well. The helicopter had proved itself an airworthy vehicle capable of rendering true transportation. It had traveled 260 miles in 5 hours and 10 minutes without even beginning to approach its high speed.

The inspection at Syracuse revealed one difficulty in this particular ship which was to cause further concern. The transmission was heating up badly. It was ironical indeed that this entirely new aircraft had passed a severe test without giving rise to structural, functional, or control problems, whereas a simple gear transmission, some-

thing that had been developed and used successfully in millions of applications for over half a century, proved to be the weak link.

The next morning the helicopter took off for Rochester. It was another beautiful day, but the hot calm air presaged a thunderstorm. At the Rochester field the helicopter landed near the hangars amidst the usual flurry of excitement and astonishment. A guard, not knowing quite what to do about the unorthodox landing, instructed the pilot to taxi up in front of the control tower at the other end of the hangar line. Little did he realize that flight was much more satisfactory for this machine than taxiing along the ground. The guard scratched his head in wonderment as the helicopter "taxied" majestically down the hangar line just a few feet above the ramp.

The control tower at this field was simply a square glassed-in box atop a 50-foot skeleton tower. Ships were not supposed to land without first receiving a green light signal from the control tower operator. When he reached the tower, Morris whirred up to the operator's eye level and stared at him. When he looked up, the tower operator was paralyzed with amazement, but he finally grasped the situation and with a big grin picked up his gun and flashed the green light.

The transmission was still running hot, so the metal cowling was removed from the sides of the ship for better air circulation on the flight to Buffalo. In addi-

tion, head winds had arisen and thunderstorms were imminent, so the pilot decided to stick close to the ground party. Then in the event of an intermediate landing the engineers would be able to check the gear case promptly.

Although the car on the highway was making the very best possible time, the helicopter was just loafing along and the pilot amused himself by dashing ahead to play traffic cop at each crossroad. If there was no converging traffic near enough to cause danger, he would signal the escort car to proceed across the intersection without slackening its pace.

As they approached the town of Batavia, the sky darkened and an occasional streak of lightning flashed through the clouds a few miles away. Morris bore northward for awhile to see if he could get around the storm, but it was spreading out and getting blacker. Not knowing what weather conditions prevailed beyond the storm front, he finally decided to land and sit it out.

Meanwhile the helicopter and its escort car had become separated in the traffic of Batavia. Two parallel roads left Batavia in the direction of Buffalo, and Morris was not sure which highway his friends would take. He zigzagged back and forth between the two roads trying to pick up the yellow dot. At the same time he carefully watched the storm's progress and kept a sharp lookout for a likely-looking house with a field and a telephone which he could use to report his position. He

could tell which houses had telephones by the lead-in wires from the poles along the highway.

After five or ten minutes the storm got too close for comfort. Morris picked out a strip of grass by an old farmhouse and came to rest safely. He reported his position by telephone and then waited for the weather to clear before proceeding to Buffalo.

After a little while, when the storm had let up and he was preparing to leave, his farmer host warned him of a hidden ditch about two hundred feet in front of the helicopter. Morris was unable to convince the man that it did not matter because he was going to take-off straight up. He finally had to abandon his attempts at explanation and assure the farmer, with much thanks, that he would be careful not to roll into the ditch.

After skirting another storm, he reached the Buffalo airport. An airliner had come in just ahead of him and a good-sized crowd was on hand to see the strange craft make an unbelievable landing.

An irrepressible sense of humor coupled with genuine pride in the capabilities of his helicopter made it impossible for Les Morris to resist demonstrating its magical performance before this audience. He purposely overshot the edge of the ramp about twenty feet. But instead of landing there, he backed up and came to rest gently on the apron. The ground party, which had arrived at Buffalo just before the helicopter, was in the crowd and heard one spectator remark:

"I never thought I'd live to see one back up!"

Although it was still early, a long string of thunderstorms between Buffalo and Cleveland rendered it unwise to proceed further that day. After an inspection, the helicopter was stored for the night.

On the following day the weather was hazy and visibility very poor—less than a mile during part of the time. Morris steered a course by compass, but endeavored to keep the highway in view in order to be able to contact the ground party if weather conditions grew too bad.

Along this stretch the pilot had an experience which vividly impressed him with the unique advantages of the type of craft he was flying. A towering radio mast loomed out of the murk just ahead of him. Of course, it constituted no hazard, for he simply circled around it. But he reflected on the advantage of being able to stop short in mid-air had it been a ridge or steep mountain side.

A little while after leaving the Buffalo airport, he picked up the shore of Lake Erie and followed it easily to his next stop, a small intermediate field at Dunkirk, New York. The field was still wet from the storm of the night before, and the attendant was dumbfounded as he watched the strange ship hover about until the pilot found a high spot near the building, where there were no puddles to step into.

The transmission was still causing concern, so in view of the nasty weather, it was decided to take one of the

ground party along on the flight from Dunkirk to Erie. A flip of the coin chose Ralph Alex. The clouds were still low and nasty-looking. Both occupants of the helicopter declared later they would have been very uncomfortable in any other kind of aircraft. It was on this flight, in the middle of a driving rainstorm, that a helicopter passenger was carried for the first time across a state line.

They reached Erie without incident, but there the weather forecasts were bad. High winds of 30 to 35 miles per hour were predicted. It was decided not to subject the new craft to the severe weather conditions ahead, particularly since head winds were promised.

The next morning, head winds of 20 to 25 miles per hour prevailed. Morris decided to take off anyhow, because the forecast indicated the probability of worse weather to come, but he figured he had a good chance of avoiding it if he got on to Cleveland.

However, a few minutes out of Erie, Morris realized that the transmission did not sound the way it should. He landed beside the highway and when the escort car arrived, it was decided that Bob Labensky would make a short flight with the pilot and try to analyze the trouble, continuing along the road near the rest of the party.

If the trouble proved serious enough, they planned to land again, but if not, they would proceed to the next scheduled stop, Perry, Ohio.

The experience proved a tough one for the passenger. Bob was convinced the flight would be short and did not bother to get an extra seat cushion out of the car. For the next hour and twenty-five minutes he sat cramped up on a hard metal seat with the circulation virtually cut off from both legs.

During this entire flight, four ears were straining to hear any untoward noises, but none appeared. As for the weather, this was the roughest leg of the entire trip. The wind was gusty, varying from 12 to 29 miles per hour. The wind was head on, too, so Morris flew close to the ground in order to avoid the stronger winds at high altitudes, which would have delayed them even more. This imposed the penalty of bumpier air, because every ravine, patch of woods or village increased the turbulence of the air.

Morris reported that they frequently lost 75 to 100 feet of altitude in down gusts, and flying at around 300 feet that did not leave a great margin. On one occasion he watched the altimeter drop 180 of the precious 300 feet and towards the end of the drop he began steering towards an open field, just in case. But the ship behaved beautifully, it did not pound and pitch. All it did was float up and down and sideways. There were no sudden shocks, and even when the craft yawed to one side or the other, it was not necessary to use rudder to straighten it out. Given a few seconds, it came back by itself.

About the time Bob began to search his limbs for

signs of gangrene, the airport at Perry, Ohio, came into sight and a few minutes later, the helicopter's passenger painfully tumbled out and started learning to walk all over again.

Battling the head winds had eaten heavily into the fuel supply and there was no gasoline at the Perry field. But there was still enough in the tank to get them a little farther along to a private field at Willoughby, Ohio. After refueling there, they started for Cleveland, the last leg of the day.

Although the weather was improving, this was a difficult section because Morris did not want to take unnecessary risks flying over congested areas. He had to sweep far to the south of the city in order to keep within reach of open plots of ground. Sikorsky was scheduled to meet the travelers at Cleveland. When the helicopter reached the airport, Morris sailed slowly down the hangar line until he saw his hangar crew and the boss. Sikorsky waved happily and beamed with pardonable pride as the helicopter settled easily onto the ramp in front of him.

The next day was Sunday. It turned out to be a beautiful warm morning with a gentle breeze and high puffs of clouds. Sikorsky was to fly with Morris from Cleveland to Mansfield. Remembering Bob's painful experience of the previous day, Les made certain that the additional seat cushion was in place before the take-off.

Morris soon turned the controls over to the inventor.

He said afterwards that it seemed strange for him to be telling Sikorsky anything about flying a helicopter, since the designer had made all the early flights with the original experimental model and had taught Morris how to fly a helicopter. But Sikorsky had been too busy to spend much time at the controls of his latest model. He quickly caught the feel of it, however, and from there to Mansfield, Morris was simply the navigator.

Since Sikorsky had never landed this particular helicopter, he returned the controls to Morris as they approached the Mansfield airport.

From Mansfield to Springfield, Morris flew alone again. It was the longest flight of the trip, 92 miles airline distance. The transmission was still causing concern and they thought it best to have the ship as light as possible over this long stretch. The miles slipped by uneventfully and he landed at the Springfield airport on schedule.

While waiting there for the ground party, an Army plane circled the port and landed. Out of it stepped Colonel H. F. Gregory, the Army Air Forces' foremost helicopter expert and ardent proponent of rotary-wing aircraft for specialized military tasks.

The ground party joined them shortly and they telephoned ahead to Wright Field to notify them of the time of arrival. The side cowlings which had been removed from around the gear case to provide better cooling on the trip were fastened on again for the dress

parade to Wright Field. The engine was started and Sikorsky again took his seat beside Morris.

Off they hopped, with Colonel Gregory not far behind in the Army plane. Bob Labensky, not wanting to miss out on the finish of the epochal flight, had hurriedly chartered a ship at the airport and brought up the rear of the procession. The pilot of the chartered plane was so pleased and excited over being included in the party that he would not accept compensation for the flight.

It was only a matter of minutes until Wright Field came into view. Two exuberant airmen, in the cabin of their helicopter, exchanged a hearty handshake. They circled down to a landing before the waiting officials to complete what was, so far as is known at the time of writing, the first aerial delivery of a military helicopter in history.

Although the trip was spread over five days, chiefly as a precaution against any possible mishap, the distance of 761 airline miles was traversed in 16 hours 10 minutes elapsed time, in 16 separate flights. The average ground speed was scarcely 50 miles per hour. Not a very impressive performance, most will agree, from the standpoint of operating requirements for a practical aerial vehicle for commercial or private transportation.

It was, however, a tremendous achievement when you consider it in relation to the accomplishments of the earliest locomotives, automobiles or airplanes and think

of the promise it held and has already begun to fulfill for the near future.

Had it not been for the war, the development of the helicopter might have dragged along many years before it became a profitable commodity in the commerce of the world. But on the basis of the performance described, plus other factors which come under the heading of military secrets, high-military, naval and civil government authorities saw fit to place orders in considerable quantities for this type of helicopter and to encourage sponsors of many other types of helicopters under development. As a result, all of the obstacles which stood between that helicopter of early 1942 and a truly practical and economically feasible helicopter for private owners have been or are in the process of being overcome.

The helicopter has captured the popular imagination of America. Many persons of all ages who would never dream of themselves hurling down an airport runway and climbing over the treetops at breakneck speed, are quite ready to accept the idea of taking off a steady, slow-moving helicopter from their own back yard.

Many persons, some of whom have never even flown before, ask such practical questions as "How much would a four-passenger helicopter cost?" Or they want to know how big a space they would need to land and store a helicopter. Frequently those who work in the city want to know what provisions will be made to land

and park helicopters near the part of the city in which their businesses are located.

Obviously, few of these questions can be answered precisely as yet, but it is not too early to start thinking about the answers and even start preparing partial or full solutions to some of the problems which can be worked out before the helicopters are actually on the market.

There are many negative voices crying out that this enthusiasm is naught but the typical extremism of the American people. They would have us believe that the expectation of private-owner aircraft on a scale comparable to America's family car is but another chicken-in-the-pot-and-two-cars-in-every-garage illusion. Beware of those pessimists; they simply are not in possession of the facts.

Already there are scores of business concerns, great and small, drawing up plans to build and sell safe, economical helicopters to the citizens of the United States—and to the citizens of the world, for that matter. These concerns include such diverse manufacturers as shipbuilders and furniture makers, and there is hardly a major aircraft manufacturer in the country who is not sponsoring a helicopter project or studying the possibility of entering the field.

With the evidence at hand now, it should not strain anyone's credulity to visualize the following incidents occurring in the very near future. Let us observe Mr.

John Henry as he leaves the breakfast table and starts for work. The Henrys live in the Catskills overlooking the Hudson River, nearly fifty miles from Manhattan.

"Hurry now, John, it's after 8:30 and you have a 9:15 appointment today."

"I have plenty of time, my dear."

"But the radio said thunderheads are forming over Westchester and you may have to circle around through Connecticut."

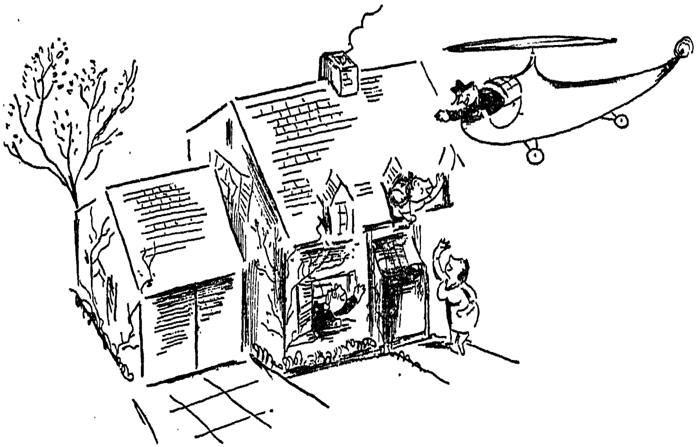
"All right, my love." John was reluctant to leave the sports page and was trying to button his vest and finish his coffee at the same time.

Mr. Henry kissed his wife good-by and hurried upstairs to the roof deck. It was about 20 feet wide by 30 feet long with a low structure at one end for storing the helicopter. Mr. Henry paused a moment and gazed down the valley at the distant horizon. Automatically he studied the cloud formation. He opened the doors and started to enter the helicopter when suddenly he stopped and, muttering darkly under his breath, pushed Junior's "girocycle" out of the way and into the corner where it belonged.

Dusting off his hands, he stepped into the helicopter and started the engine with the press of a button. "Just like the old gas buggies," he reflected. Putting it in gear, he steered the helicopter to the center of the deck, then took it out of gear and set the brake. He had just engaged the clutch which sets the rotor blades whirling

when Mrs. Henry appeared on the deck and called to him.

"Oh, John, remember the Millers are flying down from Vermont for dinner tonight, so don't be late."



"Listen, tell Junior I want to have a talk with him tonight. If he isn't old enough to put his things away properly, he isn't old enough to fly to school yet."

While he was talking, a signal light glowed on the in-instrument panel indicating that the rotor was making the necessary revolutions per minute for flight. So he eased the pitch control and gas lever forward and started rising from the roof.

His wife was calling again, so he brought the machine back and remained stationary about six feet above the roof deck.

"On your way home, stop in Jersey and pick up some of that good ice cream for dessert. We need some more soda, too. Good-by now." Mrs. Henry smiled and threw a kiss.

Grinning, Mr. Henry yelled, "O.K., honey," and pushed the gas lever forward again. He pushed the stick over lightly and, gaining speed, climbed out over the Hudson in a sweeping spiral. Having reached altitude, he throttled back for efficient cruising and switched his radio on, set for the traffic control wave length. A metropolitan area traffic control report advised him that it was safe to proceed down the Hudson at minimum altitude in spite of the impending storm. So John settled back and reached for his morning paper, the same paper which had been delivered to his home by helicopter carrier less than an hour earlier.

Mr. Henry continued reading his newspaper with an occasional glance at the instrument panel to check altitude, airspeed, oil temperature and so on, until an audible warning signal notified him that he had entered the Metropolitan area and must remain on the alert at all times. He put his paper away and maneuvered into the specified approach lane set forth in the city's air traffic regulations. By now the sky was filling with helicopters. They fell into orderly file, all those in any particular lane flying at a specified rate of speed and separated by a minimum interval. Thus, while John throttled down to prepare for his midtown landing, traffic in the lanes over-

head continued at full cruising speed toward their destinations to the south.

Arriving above his destination, Mr. Henry tuned his receiver to the frequency of the 42nd Street heliport control tower and received instructions to land. He alighted gently at the designated spot on the top of a large flat-roofed building and stepped out.

An attendant bobbed up and spoke.

"Good morning, Mr. Henry. I see the storm didn't hold you up none."

"Nope, I think it's going to blow over."

The attendant handed Mr. Henry his check, folded the rotor blades and drove the helicopter down a ramp to park it. John took an elevator to the street and a few minutes' walk brought him to his office.

CHAPTER III

HISTORICAL PERSPECTIVE

LEONARDO DA VINCI, that great Venetian scientist, artist and inventor of the 16th Century, is generally credited with originating the general idea which embodies the basic principle of present-day helicopters, that is, an airscrew or windmill-like rotor revolving around a vertical axis. The underlying principle, however, dates back countless centuries beyond that.

Da Vinci devoted considerable study to the problem of heavier-than-air flight. His notebooks and sketches show that he built many small models, some of which were flown successfully. He also left detailed plans for a gigantic flying machine which he proposed to build but was forced to give up for lack of a suitable power source.

The older device embodying the fundamental concept of helicopters was the so-called Chinese Top. Its origin is lost in oriental antiquity. But references to it are found in ancient Chinese literature and the toy in one form or another has reappeared in various places

throughout the world down through the ages. It appeared in Europe in the 18th Century after the early balloon flights of the Montgolfiers, and was demonstrated before the French Academy of Sciences.

The Chinese Top consists of two rotors, utilizing feathers as blades, mounted at opposite ends of a shaft. The pinwheels are rotated in opposite directions by means of a taut bow which pulls on strings wound around the shaft to accomplish the opposite rotation. This toy still proves popular in our own time. It frequently appears at carnivals and fairs. All of us are familiar too with the more modern versions. One consists of a propeller or rotor with a rectangular hole in the center, which is pushed upward off of a twisted rod, imparting a twirling motion and causing the spinning propeller to soar far up into the air. In another form a piece of string wound on a spool attached to the rotor is used to impart the twirling motion that causes it to rise into the air.

Incidentally the boomerang used by Australian hunters is really a kind of rotating-wing aircraft. It is kept aloft by the spinning motion imparted to it by the arm of the hunter, and if it misses the bird or other target aimed at by the hunter, it circles around and returns to its original starting point, depending of course on the skill of the thrower.

The hummingbird is the closest approximation of the helicopter to be found in nature. Its tiny wings vibrate

back and forth about fifty times a second and, unlike any other bird, it has the capacity to hover in one spot and even to fly backwards. The hummingbird also provides a good answer to the question as to why birds can fly so successfully with muscle power and man cannot. The muscle weight in a hummingbird comprises 55 percent of the weight of the entire body, whereas the muscle weight of the human body is only 8 percent of the whole.

The average man in the street thinks of the helicopter as something quite new under the sun. Many believe that the Sikorsky machine which made its first public appearance in 1940 was the first helicopter to fly successfully in all history. This of course is far from being the case, for Sikorsky himself began his first helicopter experiments in Russia in 1908, and by 1910 had succeeded in building a machine which lifted its own weight from the ground, although it could not manage to rise with the weight of the pilot added.

By that time Sikorsky was growing more interested in the design of large multiengine airplanes, so he dropped his active helicopter experimentation for over two decades. But such is the genius and persistency of Sikorsky that he returned to the problem of helicopter design and reached a dramatically successful achievement thirty years later.

Of course, Sikorsky would demur against calling his contemporary helicopter accomplishment a "success,"

for he is the kind of scientist who considers success something better and more perfect than that which he can yet envision but which he is working to achieve in the future.

Sikorsky himself recently described his early experiments:

"I started my activities in aviation by building a helicopter in 1909, with a small Anzani 25-horsepower engine with two crude propellers rotating in opposite directions on concentric shafts. The first machine achieved little results except mainly to teach me how things should not be done. This is a very important experience, as every engineer knows. In 1910 I built the second helicopter, which was lighter and had a total weight empty of about 400 pounds. The power was again 25 horsepower, with two lifting propellers of 19 feet diameter rotating in opposite directions at 150 revolutions per minute, and this was sufficient to lift the machine off the ground without a man in it. While this was done, however, the machine had to be kept inside a sort of railing because it was unstable."

The Frenchman Bréguet is credited by many authorities with having made the first successful helicopter flight, in the sense that the helicopter he designed rose vertically into the air with the pilot, remained under control of the pilot in the air, and returned to the ground safely. Around the same time Paul Cornu, also of France, built and flew a successful helicopter. But

these successes were neither sudden nor spontaneous. They represent the accumulation of centuries of study and hard work replete with failures, accidents and heartaches.

For two centuries after Da Vinci's work, helicopter thinking and experimentation were virtually nonexistent. In the 18th Century, Paucton and Launoy conducted experiments. Paucton's machine had two lift screws and was designed to be flown by muscle power, but it was a complete failure. Launoy's machine had twin rotors also, but was powered by an arrangement of springs. It got off the ground, but that was all.

Toward the end of the century, in 1796, Sir George Cayley, who worked very hard on the problems of vertical flight, built a model driven by springs which was credited with having ascended to an altitude of 90 feet. He drew up plans for a full-scale, steam-driven helicopter incorporating many ideas which later were proved to be sound, but it was never built.

Through the 19th Century a handful of scientists and inventors kept helicopter experimentation alive. Steam power was coming into its own and in 1842 Philips built a twin-rotor model powered by a small steam engine. It succeeded in rising to a height of 50 feet and traveled several hundred feet from the point of take-off.

An American engineer, Mortimer Nelson, was granted a patent in 1861 on his proposed helicopter design. His intuitive grasp of the problems of vertical lift and the

means of solution was no less than astonishing in the light of what is happening nearly a century later.

Nelson's design, for which he had drawn up plans and sketches, had twin four-blade rotors on outriggers, co-axial propellers in the nose for forward propulsion and a large circular frame with cloth secured to it to act as a parachute in case of mechanical failure. He proposed to use a steam engine of 40 horsepower weighing 500 pounds.

The excessive weight of his engine would have defeated Nelson had he built this machine. Aside from that, his plan was an amazing prophecy of helicopter types which since then have been constructed and flown.

In the years that followed during the last half of the century, many others experimented with steam-powered helicopters; and newspapers and periodicals of that day carried frequent articles and illustrations depicting the huge aerial steamers that were to come in the future.

One of the most successful experimenters was Enrico Forlanini, an Italian professor of civil engineering. He built a machine weighing only a few pounds powered by a ¼-horsepower steam engine. It ascended to heights as great as 40 feet in flights lasting as long as 20 seconds.

At about the same time, Thomas A. Edison, America's great electrical wizard, became interested in the problems of helicopter flight utilizing electricity as a source of motive power. He conducted experiments with full-sized rotors and vertical airscrews driven by electric

motors. Although he did not succeed in building a machine which would rise from the ground, the results of his careful experiments were of value to other researchers. His experiments conducted at that early date, over twenty years before the Wright brothers were to make their successful airplane flights at Kitty Hawk, convinced Edison of the ultimate practicability of the helicopter and years later, even after the airplane was an acknowledged success, he predicted that the helicopter would some day come into its own.

Edison's prophecy is being borne out today and might have been fulfilled earlier had not the success of the fixed-wing aircraft caused the vast preponderance of money and engineering talent devoted to aeronautics to be poured into the breath-taking development of the airplane rather than into a continuation and expansion of helicopter research.

In spite of the airplane's initial success and continued development, there were a few men who remained confident that the helicopter offered the best answers for certain aspects of flying. Among those who continued their helicopter work in the opening decade of the 20th Century were Maurice Leger, Bréguet, Cornu and Emile Berliner. Leger, working in Monaco, built a helicopter lifted by two 20-foot counter-rotating airscrews. A unique feature of this machine was its electric drive. The motors stayed on the ground and turned the rotors by means of flexible shafting. Although obviously not

intended for free flight, this machine succeeded in rising from the ground and enabled Leger to develop new fundamental data on lift characteristics of airscrews.

By 1907 Bréguet had completed one of the largest helicopters built up to that time. His machine weighed over 1000 pounds and was sustained by four rotors located at the corners of a rectangular framework. It was a very complicated machine and not exactly pleasing to look upon. But with it Bréguet succeeded in attaining an altitude of 15 feet and on one flight flew a distance of 64 feet.

In the same year Paul Cornu was ready to try his machine. It had two rotors mounted on outriggers somewhat like the modern German helicopter designed by Focke. Although Cornu's machine got off the ground for a few feet, it proved uncontrollable in the air and was never flown successfully.

At about the same time that Sikorsky was conducting his helicopter experiments in Russia, Emile Berliner was working hard on the problems of vertical flight in America. Collaborating with J. Newton Williams, Berliner built a helicopter which got off the ground in 1909, but an accident put an end to further experiments with this machine.

Ten years later, Emile's son Henry, who had learned to fly in the U. S. Army Air Service, resumed active work on helicopter experimentation with his father's backing and encouragement.

Henry Berliner actually built and flew several helicopters of different designs. But their success was not sufficient to warrant continued effort and by 1923 the Berliners decided to discontinue their helicopter experiments.

During World War I, two Austro-Hungarians, Lieutenant Stefan Petroczy and Professor Theodore von Karman, were working on a helicopter for specific military purposes. They built a large machine weighing several thousand pounds and powered by three 120-horsepower engines. In addition to the pilot, it carried an observer with a machine gun in an armored enclosure. Although it made about fifteen successful ascents to considerable heights, it was held captive to the ground by means of stabilizing ropes and had no provision for flying from point to point in the air. The Petroczy-Karman machine clearly demonstrated potential military values of the helicopter.

In 1923, George de Bothezat, a Russian-American aeronautical engineer, persuaded the U. S. Army Air Corps to assist him in the construction of a helicopter. The job they designed was a big, ungainly contraption with four six-bladed rotors, but it nevertheless rose into the air to heights of about 6 feet and remained aloft for a few minutes on numerous flights. It exhibited better stability characteristics than any models had shown up to that time, but the results of tests gave so little promise that the Air Corps did not see fit to continue this project.

The following year Etienne Oemichen established a record by flying his helicopter over a closed kilometer course. Oemichen's machine was a real "Rube Goldberg" contraption. In addition to its four main lift screws, there were seemingly endless small propellers and fan blades rotating in various planes to give the machine stability and directional control. It made over 1000 flights but never succeeded in getting more than a few feet off the ground.

Several other European efforts were significant prior to the noteworthy Focke achievement. Pescara, a Spanish experimenter, made a number of very brief flights in his small twin-rotor helicopter in 1926. Two Italians, Isacco and D'Ascanio, built and flew helicopters. D'Ascanio's helicopter was the most successful. On one flight in 1930 he was credited with reaching an altitude of 59 feet and covering a distance of 3500 feet, remaining in the air 8 minutes and 45 seconds. Oscar von Asboth, a Hungarian engineer working in England, in the early thirties designed a helicopter which was built and tested by the Blackburn Company.

In America, Maitland Bleecker, an engineer of the Curtiss-Wright Corporation, interested his company in a helicopter of very novel design. The Bleecker machine, built in 1930, had a single lift rotor consisting of four broad blades, each being pulled around the vertical axis by its own small propeller, gear-connected to an air-cooled radial engine mounted horizontally atop the

fuselage of the helicopter. It succeeded in rising from the ground under its own power in the hangar where it was built, but difficult engineering and aerodynamic problems were encountered and the project was abandoned.

Years went by with scarcely any public notice of helicopter development in America, when suddenly out of Germany in 1937 there came dramatic news of the remarkable Focke-Achgelis helicopter, whose performance was reported to be vastly greater than anything achieved earlier. Widespread skepticism greeted the first reports, but this was soon dispelled by repeated demonstrations of the machine's remarkable capabilities.

Heinrich Focke, successful designer of some of Germany's best military airplanes, was responsible for this machine. In 1937, Hanna Rasch, the famous German aviatrix, flew the first experimental machine from Bremen to Berlin at an average speed of 68 miles per hour. Later, pilot Ewald Rohlff took another model of the Focke helicopter up to 11,700 feet. In 1938 Hanna Rasch gave a remarkable demonstration of the stability and range of control of the Focke helicopter when she flew it inside a large sports palace in Berlin. This helicopter really achieved the first practicable demonstration of the ideal of helicopter flight—that is, it was able to ascend vertically, to hover motionless in the air, or to move ahead, sidewise or in reverse at the will of the pilot.

Following these successful demonstrations plans were reported for the construction of six-passenger commercial models of the Focke helicopter for service testing in regular passenger service. But war broke out the following year and no further reports have reached America concerning progress of helicopter design and activity abroad.

The Focke helicopter had a fuselage like a conventional small airplane with an open cockpit. In place of the wings there were simply outriggers on either side, each supporting a three-bladed rotor. These rotors were driven by means of gearing and pulleys from a single radial engine in the nose of the fuselage. These two airscrews were rotated in opposite directions to cancel out the torque reaction encountered when only a single rotor is used.

All during the twenties and thirties, the autogiro and giroplane, similar forms of rotating-wing aircraft, were being steadily developed. Since Juan de la Cierva, the Spanish engineer who invented the autogiro, successfully demonstrated the practicability of that type of aircraft in 1923, the development of giro types of aircraft had kept well ahead of helicopter development. You will recall that the chief difference between these two types is that direct power is not applied to the rotor in the giroplane or autogiro, rotation of the blades being achieved by aerodynamic forces set up as a result of the craft's movement through the air; whereas in the heli-

copter the power is applied directly to the one or more rotors which sustain the machine and control its movement in any direction.

The progress in the development of autogiros, giroplanes, cyclogiros, and convertaplanes during the past twenty years is an interesting and important chapter in the history of aeronautics in itself. But it is not properly a part of this story of the helicopter except for this: many mechanical, engineering and aerodynamic problems relating to the lift characteristics of rotors or vertical propellers, and methods of achieving stability and controllability, were identical or similar. Thus helicopter development has benefited greatly by the forward strides made in autogiro design and, by the same token, the giro type would not have been so successful had it not been for the long history of helicopter research.

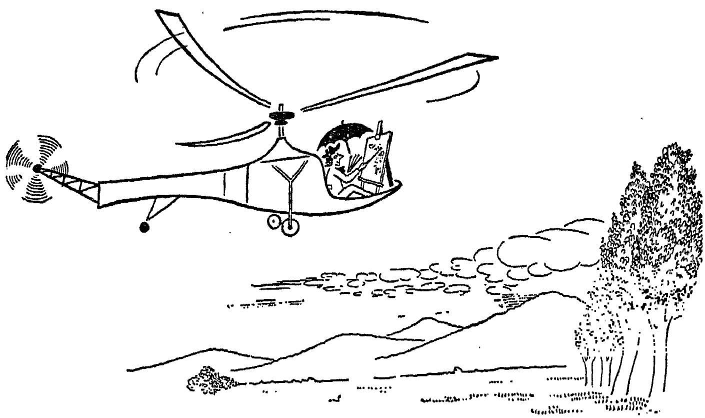
CHAPTER IV

HELICOPTER DESIGNS

MANY questions will occur regarding the reasons for two rotors in the Focke helicopter, a single rotor in the Sikorsky helicopter, four rotors in some of the earlier designs and so on. The reasons for the variety of designs and the many different methods of achieving the same objective lie in the scientific domain of aerodynamics and engineering. But it does not follow at all that you must have an engineering education or technical knowledge to understand the broad general principles involved.

Torque reaction is a forbidding phrase and in helicopter design it tends to be an engineer's nightmare. The essential meaning however is not difficult to grasp. The source of power (gasoline engine) in the body or fuselage of a helicopter imparts a twisting motion to the vertical shaft which rotates the blade of the lifting airscrew. When any force is applied in a specific direction, an equal force in the opposite direction results. Therefore if the main body of the helicopter is simply suspended from a single rotor, the body of the craft would tend to spin in a direction opposite to the rotation of the airscrew.

Sikorsky, in his helicopter design, overcomes this difficulty by providing a long outrigger to the rear of the main body of the craft and attaching to it a small propeller rotating in a vertical plane. This propeller tends to pull the tail of the helicopter sidewise in the direction



opposite to the torque reaction. The small propeller is automatically regulated so that it keeps the body of the helicopter pointing steadily in any given direction. But by increasing or decreasing the pitch of the blades, at the will of the pilot, it becomes a rudder. For example, it is possible for the Sikorsky helicopter to hover motionless in the air in relation to the ground, while the pilot slowly rotates the body of the craft in either direction to survey the entire horizon.

Other designers, Focke for example, have sought to

eliminate this problem of torque reaction by using two rotors rotating in opposite directions, thus canceling out any tendency of the body of the craft to rotate. However, most engineers now believe that additional rotors only increase the problems of stability and control while reducing the safety factor. For example, if anything happens to the mechanical apparatus, or aerodynamic trim, of one of the rotors of the Focke helicopter, the machine would be immediately thrown out of balance and almost certainly would crash. Whereas, if a similar minor defect occurred in a single-rotor design such as Sikorsky's, the machine would have a most excellent chance of descending safely to the ground, where the difficulty could be ascertained and repaired.

In earlier designs, where some experimenters used four lift screws, the two additional ones were added to gain stability fore and aft. Experimentation with different arrangements will continue in the effort to achieve the best possible design. But I feel confident the single-rotor design will win out and maintain superiority over other arrangements by virtue of its greater simplicity, greater safety, and minimum waste of power to achieve stability and control.

Some designers have sought to overcome the problem of torque reaction by using two rotors, but mounting them one above the other instead of side by side. In this arrangement the two airscrews rotate in opposite directions around the same vertical axis. This immediately

introduces new problems in addition to those encountered in the side-by-side arrangement. The bottom rotor, for instance, loses some of its efficiency because of the downwash and disturbance of air by the top rotor. This arrangement does have the advantage of smaller radius of rotor blades for a helicopter of given size.

There is only one thing that we can be positive of, that is, that the final solutions have by no means been reached as yet. During the course of the war much progress has been made in the utilization of the principle of jet propulsion. Engineers have learned how to use the powerful exhaust blast from gasoline engines to increase the speed of aircraft. The same source of energy is used to operate America's world-beating turbo-supercharger which enables our aircraft to achieve unparalleled performance at extremely high altitudes.

It is quite conceivable that the exhaust blast could be used to counteract torque reaction in a single-rotor helicopter and thus eliminate the mechanical complexity and power loss entailed by the auxiliary propeller. By regulating the force and direction of such a jet arrangement, steering control also would be accomplished.

One engineer has suggested that a gyroscopic mechanism of his devising would accomplish the same result with considerable efficiency. On the other hand, still better solutions may repose unsuspected as yet in the brain of some engineering student or grease monkey now devoting his energies to winning the war.

The coming years undoubtedly will see many diverse types of helicopters and even craft which will combine the essential features of the helicopter with other features of the autogiro or conventional airplane. In some cases perhaps a combination of all three will be developed. It was so with the airplane. Most of you will recall the time when there were more biplanes than monoplanes. The monoplane won out at last because it proved more efficient than the competing type.

The Sikorsky XR-4, the first model delivered to the Army Air Forces, is representative of the single-rotor type of helicopter. In its two-place cabin the occupants sit side by side in front of the engine and the vertical shaft to the overhead rotor. Vision is entirely unobstructed forward, upward and to either side. Additional transparent panels in the side, nose and floor provide good vision downward and directly underneath as well.

It is powered by a Warner 165-horsepower engine which drives both the main rotor and the small tail rotor. The main rotor has three long, slender blades radiating from the hub. Each of the blades is approximately 18 feet in length, tapering gradually to the tips.

The auxiliary tail rotor which revolves in the vertical plane is merely a miniature three-blade propeller with variable-pitch blades. The pitch control mechanism of the tail rotor is connected to the rudder pedals so that it provides directional control as well as serving its main purpose of correcting torque.

The pitch of the main rotor blades can be increased or decreased at will as they pass any desired point of rotation, with a corresponding but opposite variation of pitch at each half revolution. The pitch of the blade means the angle at which it "bites" into the air.

The method of control and mechanical arrangement of the Sikorsky helicopter is simplicity itself—perhaps that is why it has made the greatest progress of any helicopter to date.

Inside the cabin, the instrument panel is similar to that of any small private airplane, except that there are two tachometers, one for the engine and the other for the main rotor. The control stick rises vertically from the floor between the pilot's legs. A lever at the left, used for altitude control, governs both the pitch setting of the main rotor blade and the engine power. As the pitch is increased the power is increased also to maintain a constant speed of rotation.

On the main rotor shaft just below the hub, two circular plates are fixed together in sandwich fashion. The filling of the sandwich is a bearing which permits the top plate to rotate while the bottom plate cannot. From three points on the periphery of the top plate short push-pull links connect with short arms on each rotor blade. If the plate remains horizontal with respect to the vertical shaft, the blades revolve without changing pitch during each revolution.

Pushing the stick in any direction causes the bottom

plate to tilt in a corresponding direction. When the bottom plate is tilted the top plate tilts right with it and continues to rotate. Now, however, the push-pull links follow the inclined plate; as the link travels around the lower side it pulls down on the arm attached to the blade which governs its pitch, thereby reducing the pitch of that particular blade. As the link slides upward, the pitch will return to normal at the half-way point and increase to the maximum as it reaches the highest point. This action is referred to as "cyclic" or "azimuthal" control.

As the pitch of each blade decreases, the blade itself will tend to ride lower in relation to the shaft; as it increases, the blade will ride higher. In other words, each blade alters its pitch gradually and returns to its original setting during every complete revolution. The result is a self-induced tilting of the entire path described by the blades in rotation. The craft then moves in the direction of the tilt. This action produces longitudinal and lateral control.

Control is not secured by tilting the main shaft. The rotor shaft is mounted rigidly with respect to the fuselage. Of course, the entire craft tilts slightly in the direction of flight, but it is a result of the control and not the cause of it.

Under the pilot's feet are conventional rudder controls. Steering is accomplished by changing the pitch of the tail rotor. Assuming that the main rotor revolves clockwise, the fuselage tends to rotate in the opposite

direction. Therefore, in straight flight the tail rotor pulls the rear of the ship toward the pilot's left with just sufficient force to balance the torque reaction. The tail rotor is geared to the main rotor so that when the pitch of the main rotor is increased, thus causing greater torque reaction, the tail rotor pitch is increased proportionally, automatically holding the fuselage in a direct line.

To steer to the right, for example, the pilot pushes on the right rudder pedal. This increases the pitch of the tail rotor beyond that needed to equalize torque reaction and the additional thrust pulls the tail sidewards to the left, turning the nose of the ship to the right. To make a left turn, the pitch is decreased to less than that required to equalize torque reaction and the tail swings to the right, facing the nose of the craft to the left. The pilot co-ordinates the rudder movements with the stick to keep the fuselage facing in the direction of flight.

Although this mechanical explanation may sound involved, it is not really so in operation. The process is no more difficult than accelerating speed as you steer your car to the right or left coming out of the garage, or applying the brakes while rounding a turn. When hovering in a stationary position, rudder pedals merely twist the fuselage in either direction at the will of the pilot, or even spin the body of the craft around and around. In swinging the tail in the direction of the torque reaction, negative pitch can be applied to augment the

torque reaction if the rudder pedal is depressed far enough.

Every bit of control of the Sikorsky helicopter is accomplished by blade pitch-changing. The main rotor blades may change pitch altogether, which controls climb, or cyclically, which controls direction of flight, or in any combination of the two.

After the engine is started and warmed up, a clutch is engaged which starts the rotors turning. The stick is held in a neutral position and the throttle is set at the point which brings the main rotor up to the revolutions per minute specified for take-off. At that point, the pilot pulls up on the pitch-control lever—remember, the throttle is synchronized with this pitch-control lever so that the additional power required with greater pitch to maintain the constant speed of rotation is provided—the main rotor blades bite into the air and the craft rises gently upward. The altitude in vertical flight is controlled by upward or downward motion of the pitch-control lever.

When the desired altitude is reached, the pilot eases forward on the stick and when a speed of 10 or 15 miles an hour is reached, the craft starts floating skyward without increasing the pitch or doing anything else to cause ascent. To fly level, it is necessary to reduce the pitch somewhat. The extra lift caused by the forward flight is called "translational" lift and comes from the horizontal movement of the rotor disc through the air.

The greatest power is required in hovering. Horizontal movement, except at maximum speed, decreases the amount of power required to fly at any given level. For this reason the helicopter can fly with considerable excess loads if vertical speed is sacrificed. By over-revolving the rotor at low pitch, then increasing the pitch suddenly, a "jump take-off" can be effected. The helicopter promptly proceeds into forward flight to attain the necessary added lift.

Ground cushion effect is an interesting phenomenon of helicopter flight. This effect is noticeable up to a height equal to half the diameter of the main rotor. The downwash of air through the rotor flowing against the ground causes this cushion. When a helicopter descends very slowly, it drops to a point a few feet off the ground and then will descend no further until the pitch of the blades is further decreased by the pilot.

When the engine of the Sikorsky helicopter stops during flight, an automatic pitch-reduction mechanism reduces the pitch of the main rotor blades to the proper setting for a power-off glide. A free-wheeling device disengages the shaft from the engine so that the rotor does not have that additional drag. The tail rotor remains geared to the main rotor so that directional control is retained by the pilot.

The approved technique for landing with power off is to glide forward at anywhere from 20 to 40 miles per hour. This gives the helicopter a considerably slower

rate of descent than in vertical descent with the rotor in autorotation. Just before reaching the ground the pilot eases back on the stick to slow the forward motion and land at 5 to 10 miles an hour, which results in a negligible ground roll.

If it is necessary to land vertically with power off, it can be done, but the impact might be hard enough to damage the landing gear. There would be no danger, however, of injury to the occupants if they remained in their seats and the craft landed on a reasonably flat surface.

Another helicopter design, employing two rotors, one above the other, rotating in opposite directions around the same vertical axis, is exemplified by the de Bothezat GB-5 helicopter. It was designed by the late Dr. George de Bothezat, who had built a helicopter for the United States Army in 1922, and was manufactured by the Helicopter Corporation of America.

De Bothezat was a mathematical wizard who pioneered in the design of efficient airfoils for lifting rotors. The size and shape of his blades were determined by elaborate mathematical computations. It was reported that when he first saw blades made in accordance with his mathematical specifications, he commented on what a beautiful shape they turned out to be.

The term "co-axial" is used to describe twin rotors or propellers revolving on a common axis. As has been

seen, this arrangement was tried many times before. But the de Bothezat design, so far as is known, is one of the most successful of its type to date. A most unusual feature of the design is the location of the engine between the counter-rotating blades and outside the cabin of the helicopter.

The GB-5 has a one-place cabin, very stubby, but neatly streamlined. Control of the GB-5 is similar to other helicopters. The rotor is disengaged as the engine starts, but when the throttle is opened an automatic clutch engages the rotor drives and starts them whirling. The control stick governs the direction of flight by shifting the entire rotor-engine unit slightly, and tilting it in the direction in which it is desired to travel. A forward movement of the control, for example, slides the rotor-engine unit slightly rearward, and at the same time inclines it forward.

In the de Bothezat design the rotor blades do not vary in pitch during each revolution as in the case of the Sikorsky helicopter. When the pitch is deliberately altered to increase or decrease the rate of climb or descent, the pitch of all blades is changed simultaneously.

Since the two rotors revolve in opposite directions, canceling out the torque, there is no need for an auxiliary tail rotor. Steering is accomplished by varying the pitch of one set of blades from the pitch of the blades on the other rotor, thus deliberately inducing torque,

which swings the cabin of the craft in the desired direction.

Extreme simplicity of control also is claimed for the de Bothezat helicopter. With the engine and rotors turning at climbing speed on the ground, the pilot merely moves a handle next to his seat which increases the pitch of all the blades. Then the ship climbs straight up. When the control column is moved in any direction, the helicopter immediately starts traveling horizontally in that direction.

To go into level flight from a climb, the control column is pushed forward, tilting the engine and rotors until the craft stops climbing. The engine, of course, tilts with the rotors but does not rotate. The whole engine-rotor unit slides horizontally in a direction opposite to and proportional to the amount of tilt, to maintain the center of gravity of the engine-rotor unit above the center of gravity of the entire ship.

By pushing the stick still further forward the ship would fly forward and downward, but the speed would increase unless the throttle were eased back. By pulling the stick back beyond the position required for horizontal flight, but not all the way back to the neutral position, the helicopter would fly forward and upward. To maintain the same relative speed the throttle would have to be increased because of the greater pull which would have to be exercised. Thus, by co-ordinating the angle of the control stick with the throttle, any angle of flight

can be accomplished with speeds ranging from zero miles per hour to the maximum speed of which the helicopter is capable.

Before his death, de Bothezat designed a tiny version of the helicopter described which he called the "Heli-Hop." Weighing only a few hundred pounds with an engine of 25 to 30 horsepower, it was proposed as a simple one-passenger flying motorcycle.

De Bothezat also had confidence in the feasibility of giant helicopters carrying upward of fifty passengers. And, like many other proponents of rotary-wing aircraft, he believed the helicopter to be potentially a more efficient form of aircraft than the fixed-wing airplane could ever be, even after reaching its maximum development.

The famous French aircraft designer and manufacturer, Bréguet, just before World War II, had submitted to the French Academy of Science a project for a giant transoceanic helicopter. In view of his long record of outstanding achievement in aircraft design and manufacture, coupled with his helicopter experiments dating back to the early years of the century, his claims are respected by aeronautical authorities everywhere.

This design proposed a long, slender, torpedo-like body, very much like a conventional fuselage of a large transport airplane. It was to be supported by twin co-

axial rotors, but unlike the de Bothezat design the engines were to be placed amidship.

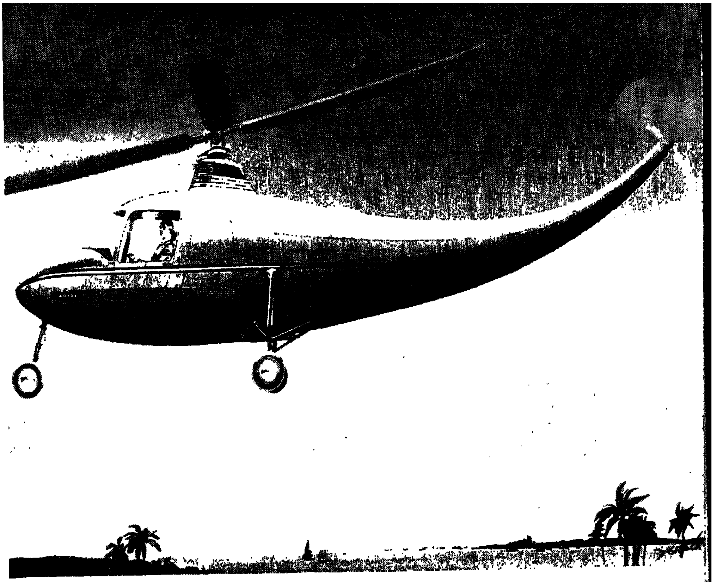
Bréguet estimated that this helicopter would travel at a speed of 310 miles an hour at 10,000 feet, with a total load of 16 tons. So far as is known, the war interrupted further consideration of his project, but Bréguet is believed to be still devoting his talents to the cause of the United Nations.

E. Burke Wilford, Philadelphia engineer and inventor who has long been active in the development of rotary-wing aircraft, has designed a two-place sports helicopter which he proposes to build soon. To be powered by a 100-horsepower engine, his design incorporates a single three-bladed rotor atop the cabin and a small tail rotor for steering and torque compensation.

The helicopter to be manufactured by Higgins Industries, Inc., was designed by Enea Bossi. The body of the craft is similar to the fuselage of a small two-seater light plane, except that there is no engine in the nose and, instead of the tail surfaces, the rear part is tapered upward to support a small tail rotor.

As in other single rotor designs, the small tail rotor is a variable-pitch anti-torque propeller which also acts as a rudder. This helicopter has a single four-blade rotor and is powered by a 180-horsepower air-cooled Warner engine. It is equipped with tricycle landing gear.

Three important features claimed for the Higgins-Bossi helicopter, are: (1) that it will travel at approxi-



Two-place privately owned helicopter designed by Enea Bossi for Higgins Industries, Inc., has four-blade rotor, tricycle landing gear.

(*Facing page 56*)

mately the same speed as an airplane equipped with the same engine and carrying the same load; (2) that its inherent stability is such that it can be flown with hands off the controls; (3) the fuselage always remains in a horizontal position.

Late in 1943 still another helicopter made its first appearance and was put through its paces in a public demonstration at Washington, D. C. It was a single-place, 1000-pound model, designed and built by the P-V Engineering Forum. Pennsylvania Central Airlines was known to be interested in this project and to be sponsoring it to an undetermined extent.

The model demonstrated was designated the PV-2. In its outward appearance it is similar to the Sikorsky design. It has a single main rotor, three-bladed, with a diameter of 25 feet. The method of control is virtually the same as that described for the Sikorsky helicopter, but company engineers claim that the mechanical means of accomplishing pitch change are considerably simplified. It also uses the principle of cyclic pitch control to tilt the plane of rotation of the main rotor in the direction of flight.

Torque is compensated for by a small auxiliary rotor on the tail only 5 feet in diameter. Here again rudder action is accomplished by changing the pitch of the tail rotor.

It is powered by a Franklin four-cylinder air-cooled

engine developing 90 horsepower. An unusual feature of the design is the mounting of the engine with its crankshaft in a vertical position. To lessen vibration the engine is set in rubber mountings and a universal joint in the drive shaft is provided to compensate for movement of the engine.

The PV-2, according to company officials, has a cruising speed of about 55 miles per hour and a top speed of 90 to 100 miles per hour. Engineers said they were confident of increasing this performance with refinements in design.

The company also described another model which was in the blueprint stage at that time, which was designed to carry a pay load in excess of one ton with a range of 400 miles. This size helicopter would carry eight or ten passengers with baggage. The company also was planning a two-place model which would be only slightly larger than the PV-2.

Each of the main rotor blades is 9½ inches in width, with a total area of about 8 square feet. The rotor normally operates at 270 revolutions per minute. The spars for the rotor blades are made of 1⅛-inch steel tubing, tapering slightly toward the tips.

For latest developments in this field see p. 162.

Small one-passenger helicopter built by P-V Engineering Forum, Inc., undergoing successful demonstration flight at Washington National Airport. (*Aviation News photo*)

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CHAPTER V

HELICOPTERS AT WAR

HELICOPTER development was not sufficiently advanced for the helicopter to play a very important role in World War II. It was not until the fifth year of the war that the military and naval services of the United States began to get deliveries of helicopters in any numbers. Had this type of aircraft been a couple of years farther along in development when the war started, the story might have been quite different. You may rest assured, however, that the helicopter will be an important element of air power to be reckoned with in future wars.

Again it is not a question of helicopters competing with other aircraft, but the ability of the helicopter to do certain things which no other vehicle can do under any circumstances. Had the United States military services possessed at the time of Pearl Harbor 20,000 helicopters—even of elementary design—to throw into antisubmarine patrol and detection, who can say how many months earlier victory would have been achieved?

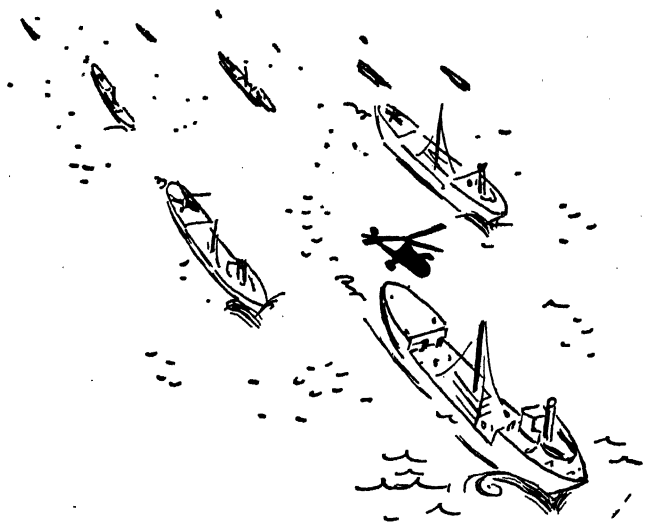
The helicopter is a well-nigh perfect form of shipborne aircraft. It does not require much storage space,

and can take off or land from a hatch cover, whether the ship be at anchor or steaming ahead at full speed. You are doubtless familiar with one of the compromises adopted during the war to combat the submarine menace. Some of the merchant vessels of the allied nations' supply fleets were equipped with catapults to launch fighter planes from the decks to deal with attack by enemy aircraft, or in some instances to ward off submarine attacks if the U-boat were detected in time. These fighter planes had no landing gear and, once launched for an attack or a defensive mission, the airplane was sacrificed. Unless shot down by enemy action, the pilot had a good chance of survival. If within range of friendly territory, the pilot could fly to land and either bail out or make a crash landing; but if he were catapulted from the ship far out to sea, his only recourse was to make a crash landing near the mother ship and be picked up by the ship's boat—if he survived.

Now, imagine each lone merchant vessel or transport provided with two helicopters to maintain constant patrol around the vessel. While one was patrolling, the other machine would be getting refueled and serviced. In the event of detection of enemy undersea craft, the second helicopter could join in the attack. In a convoy, not all ships would necessarily be equipped with their own helicopters, but a sufficient number would be assigned to a convoy so that constant patrol could

be maintained over the entire convoy area throughout the crossing.

The conventional airplane suffers certain handicaps in dealing with undersea craft. Its speed is so great in



comparison with that of the U-boat that even after sighting a submerged submarine, the pilot must swing in a long circle and make a run on the target. Under certain circumstances it is impossible to find the submarine again even though it has been sighted once and is known to be in the vicinity.

In antisubmarine warfare the helicopter, however, is in its element. If the submarine is surfaced, the helicopter does not provide a very easy target for the

U-boat's guns and is capable of very erratic maneuvering to escape antiaircraft or machine gun fire. In patrolling or searching, the speed of the helicopter is such that its occupants have a much greater chance of spotting anything on or under the surface, and in the event of any questionable objects or shadows the helicopter can stop or descend instantly for a thorough investigation.

Having once sighted the submarine the helicopter equipped with bombs or depth charges can hang over it like a bird on a perch, and blast the sub to kingdom come with scarcely a chance of a miss. Even without defensive armament the helicopter which spots a submarine can hang onto it like a bloodhound on the trail while directing surface craft or other aircraft to the kill.

Tests were conducted early in 1943 in which helicopters took off and landed from special platforms erected on a ship's deck. As a result the Navy began ordering helicopters.

Shortly after, Rear Admiral Howard L. Vickery, vice chairman of the United States Maritime Commission, revealed that Liberty ships were being designed so that small decks could be installed without interfering with their cargo arrangement. These decks, he added, were for the purpose of permitting helicopters to be used at sea to give vital cargo ships added protection from the submarine menace. On the other side of the Atlantic, Captain H. H. Balfour, Undersecretary of State for

Air, publicly announced that Great Britain had arranged to acquire Sikorsky helicopters for the Royal Navy's Fleet Air Arm.

To the United States Army Air Forces and its predecessor air services is due great credit for fostering and encouraging the development of helicopters in this country. As far back as 1918 the Air Service made an investigation of the Peter Cooper Hewitt helicopter. A design of the J. E. McWhorter autoplane helicopter was studied and reported on the following year. As we have already seen, the Air Corps subsequently entered into a contract with George de Bothezat for the construction and testing of his machine. One of the Berliner helicopters also was tested during 1924. In the ensuing years the Army gave encouragement and assistance to the designers and manufacturers of other rotary-wing aircraft, chiefly the autogiro. The Army Air Corps during the late thirties purchased a number of autogiros, and after completing its own tests conducted numerous experiments in co-operation with other branches of the Army.

With the Field Artillery, the autogiro was used in reconnaissance by unit commanders, in controlling columns on the march, for transportation of key personnel, and for various other missions.

The utility of the autogiro also was tested out with infantry units, with the regular cavalry and also with the mechanized cavalry. In all cases reports gave favor-

able indications of the utility of such aircraft operating in co-operation with ground forces.

In 1938 a school devoted solely to training of autogiro pilots and mechanics was established and activated. The Army Air Forces have been particularly interested in the development of a satisfactory helicopter because of the following considerations.

On low-pressure floats the helicopter can land on any kind of surface; ground, water, swamp, solid ice, thin ice or snow. It needs no prepared landing field, hence can operate with the most advanced units of the Army ground forces.

The helicopter can fly when airplanes cannot. Under conditions of zero visibility it can practically feel its way through the air, flying around trees and over buildings and other obstacles.

As an elevated observation platform for direction of artillery fire, it could maintain contact with ground units by direct line telephone or two-way radio.

The helicopter would be less vulnerable to enemy attacks than a liaison plane because, having no wings, it is more difficult to spot and presents a smaller target. Suitably camouflaged, the helicopter hovering stationary in the air near the ground would be difficult to spot by enemy aircraft patrols.

Perhaps the helicopter's greatest potentialities lie in its adaptation to infiltration tactics and night missions behind enemy lines. With engine-exhaust muffled, and

having no propeller noise, it could operate in almost absolute silence. It could be used to transport personnel and critical materials to strategic locations otherwise inaccessible.

In the sphere of saving human lives, not only in war but in peacetime as well, the unique potentialities of the helicopter have scarcely been appreciated. No other vehicle could be used so efficiently for the evacuation of wounded from the front lines. In spite of adverse weather conditions, difficult terrain, or roads congested with men and materials advancing to the battle zone, helicopters could transfer the wounded to well-equipped base hospitals without delay or hindrance.

In the case of torpedoed or bombed transports, merchant vessels or warships, helicopters could engage in and direct rescue operations in ways superior to all other ships of the air and the sea. No matter how rough the water, the helicopter could pick up survivors without difficulty. When filled to capacity with survivors, the helicopter still could drop food or drugs into the very hands of men on life rafts or afloat in the sea. The helicopter also could drop lines to tow stragglers to life rafts or larger rescue craft on the surface.

In the case of shipwrecks or other disasters off our shores, helicopters in the future can descend and pick up passengers and crew members from the very decks of disabled vessels.

The helicopter could be used for specialized types of

bombardment and photographic missions where other aircraft would be handicapped. The helicopter under certain conditions conceivably could hover silently and invisibly over enemy territory and take photographs by means of infra-red photography without being detected. Similarly, a helicopter might gently lower a delayed-action bomb on an enemy roof where it would do the most good and float away without detection.

The helicopter could also greatly simplify the task of laying communication wires over difficult or impassable terrain. Sheer cliffs, matted undergrowth of the jungles or mountain gorges would present no obstacles whatever to a helicopter's unreeling communication lines in a straight line towards the objective.

I do not think we will see it in this war, but the next war may very well see the adoption of one inventor's suggestion of one-man helicopters by the thousands to land fully equipped troops behind enemy lines, somewhat as paratroopers are used now. Soldiers so equipped would enjoy tremendous advantages over paratroops in that they could control the precise time and place of landing and be ready to fight the moment their feet touched the ground, without having to tumble and disentangle themselves from their parachute harness and then find their comrades and assemble the heavier weapons.

Fantastic as this proposal may sound now, it is certainly no more fantastic than the idea of using masses

of troops dropped by parachutes from transport planes for invasion purposes would have seemed to the average person a mere ten years ago. Such troops could land in pitch darkness with relative safety under conditions which would be sheer suicide for parachute troops.

This review of a considerable number of possible present and future applications of helicopters in warfare opens the way for further speculation by the more imaginative. More specific information concerning actual uses cannot be divulged because of requirements of military security.

CHAPTER VI

HELICOPTERS IN COMMERCE

AN AIRCRAFT in the hands of a private owner is not an airplane or a helicopter in commerce. However, the manufacture, sale, distribution and upkeep of a private aircraft constitutes an important phase of air commerce—a phase which must grow to be the backbone of aviation before the industry can become a factor in our national economy comparable to the automotive industry.

For the past decade and more many aviation leaders and others interested in the progress of aeronautics have prophesied, exhorted and tried by every known means of salesmanship to develop a so-called mass market for the private airplane. They reckoned not, however, with several realistic limiting factors. Despite all their efforts there is still only one privately owned airplane for about every 2500 automobiles in the United States. Moreover, this country has more private aircraft than all of the rest of the world combined.

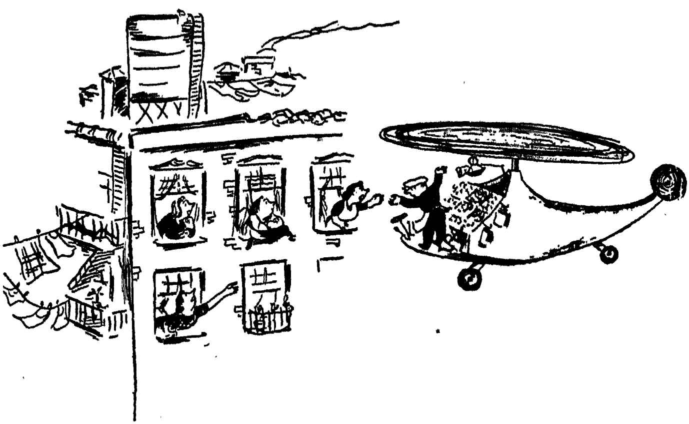
One limiting factor was first cost, but it was not the chief one. Good, reliable airplanes were available in the price range of expensive automobiles. Thousands of per-

sons who could afford to, bought such planes—many of them learned to fly after making the purchase—but did not hang on to them very long. Statistics assembled covering the years preceding our entry into the war show that most lightplane purchasers resold their planes before they had owned them a year.

Another limiting factor was the cost of maintenance. Even though the aircraft engine has become highly efficient and reliable, it requires far more care and attention than an automobile engine. Highly skilled licensed mechanics must perform the inspections and repairs and their services do not come cheaply. The same thing is true generally of the rest of the airplane and its equipment. The airplane takes up considerable floor space in a hangar and the fees are pretty steep, particularly in view of the fact that in many cases fees charged for storage and other services must absorb part or all of the operating costs of the airport. But even the high cost of upkeep was not the most serious limiting factor, for a great many of those who gave up private flying as a bad job after a while were people who could well afford the expense if they got something in return that they wanted.

The really big obstacle to the wider adoption of the low-cost lightplane was its inutility. Suppose that to use your automobile you had to journey out to a municipal autoport and, once started, couldn't drive less than 50 miles an hour and then could only stop at speci-

fied areas still many miles removed from your ultimate destination? Unless you were one of those persons with a crazy and irresistible urge for speed at any cost, you would not want to be bothered with an automobile at all. Truly, a horse and buggy would be much more con-



venient for visiting your friends and conducting your business in the vicinity and there would always be the very efficient railroads for longer distances.

The lightplane before the war was handicapped by a limited range, and speed scarcely greater than surface transportation. In addition, airports were very limited in number throughout the nation and in many cases servicing facilities were uncertain or nonexistent. Private flying in the prewar years was a hobby, recreation or sport; it had little or no utility value.

To digress from helicopters for a moment, I might point out that all this is going to be changed after the war. The number of classified airports in the United States had jumped to approximately 3000 as of mid-1943 and these probably will increase to the 4000 total contemplated by the Federal Government's prewar airport plan in the very near future. In addition, hundreds of military training fields and auxiliary landing fields required for the war training program probably can be converted to civil uses after the war.

The helicopter enjoys unusual advantages with respect to ground facilities required. For landing and take-off it needs less than 1/100 of the area required for the average airplane. The surface does not have to be heavily reinforced as the airport runway must be to withstand the heavy impact when airplanes bounce on landing. The helicopter can land on any reasonably level, unprepared surface in perfect safety, whereas the airplane cannot.

The same technological advances which are increasing the efficiency and decreasing the relative costs of military and transport aircraft will to a large extent accomplish the same thing for postwar private-owner aircraft. One thing is certain: safe and efficient small airplanes will be available shortly after the war which will cost no more to own and operate than a medium-priced car.

In the early stages, at least, the small conventional

airplane may be cheaper than a comparable helicopter. However, Sikorsky has pointed out that the helicopter lends itself to mass production to an even greater degree than the conventional types of airplanes now rolling off the assembly lines by the thousands. He states that production of the helicopter and its parts is more nearly comparable to automobile production than to the production of conventional aircraft. The helicopter eliminates the need for large wing areas and control surfaces which, since they must be strong, smooth, light and very exact in shape and contour, involve tedious methods of construction and expensive materials.

In rural areas where airports are in closer proximity to homes, this initial economic advantage will favor the new family "aircars" as against the helicopter. This is chiefly because of the years of additional experience which the aircraft designers and builders have assimilated. There are no technological reasons why the helicopter will not be just as cheap to build after development has caught up with the airplane. The cost of operation of the helicopter probably will always be somewhat greater than that of an airplane of comparable weight-carrying capacity. But here again the much greater utility, the ability of the helicopter to do all of the things the small airplane can do plus so many things that its competitor cannot do, would more than justify a slight added cost of operation.

Dr. Sikorsky has stated the case as follows: "Frankly,

I believe that when it comes to ferrying heavy loads at considerable speeds for long distances, the airplane will remain the most efficient and successful type of aircraft. However, for certain kinds of service, convenience of operation may prove to be more important than load-carrying efficiency. If for instance we compare the automobile with the railroads, the amount of ton-miles per pound of fuel in the railroads is much greater than in the automobile. And yet we see considerable development in the automobile and the ability of the motorcar in many respects to render a service of its own which is so valuable that no railroad could replace it."

An indication of the seriousness with which the transportation industry as a whole views the development of the helicopter is contained in applications now on file with the Civil Aeronautics Board to provide additional air transport service at the end of the war. By mid-1943 the total mileage covered in these applications exceeded 350,000 miles. The 80-odd companies and individuals who made these applications represent existing commercial airlines, proposed new airline companies, bus, truck, railroad and steamship operators and private individuals. The magnitude of this total route mileage applied for is better appreciated when contrasted with the total railroad mileage in the United States, which is about 238,000 miles.

Of this total, slightly more than 20 percent, or 75,922 miles, represents helicopter routes applied for. This does

not include the so-called "indefinite" applications in which permission is sought to serve an entire state or region without specifying particular routes and terminals. In the pick-up field, which most likely will fall to the helicopter in the future, applications total more than 55,000 miles.

No less an authority than Charles I. Stanton, Administrator of Civil Aeronautics for the Federal Government, has stated, "The helicopter may well take over the collection and distribution functions now performed by the 'mail pick-up' operations. It seems to me that the pick-up scheme can serve best as a preparation for a service of wider scope. It is all right to yank a bag of mail off the ground at flying speed and wind it up into the plane, or even some kinds of express matter, but what if it is a passenger that wants to go?"

Air mail pick-up service pioneered in recent years provides the benefits of air mail service to small outlying communities through a mechanical device which enables a pilot to pick up sacks of mail in full flight, thus eliminating a fully equipped airport as a primary requisite for air mail service. To deliver the mail on such a route, of course, is simply accomplished by dropping the mail in the appropriate place. So, as Stanton points out, why not use the helicopter instead, which can pick up and deposit passengers and express as well as mail.

The scoffers against anything that is new and those reactionaries who resist a change in any form will put

forth some mighty convincing arguments against these predictions ever panning out within our lifetime, and so on. They will recall that optimists and prophets of ten and twenty years ago were predicting that the aircraft industry would shortly rival the automotive industry and that we would have private airplanes by the millions. All that is very true. Every new industry, every new development suffers in its adolescence from overconfidence and enthusiasm and also from unscrupulous men who exploit that optimism and enthusiasm for their own profit, to the tragic detriment of a struggling new idea. That was true of the railroads. It happened in the development of the automobile and we saw it happen in aviation's recent history.

So when I say that this is different, I hope to make it convincing. Only those persons who are acquainted at first hand with what is now going on in wind tunnels and laboratories shrouded in secrecy and in vast industrial plants behind carefully guarded gates can fully realize that the various elements which were lacking in the past to make possible the mass acceptance of flying as a means of individual transportation have been supplied one by one, so as to finally remove the barriers to the fulfillment of this goal.

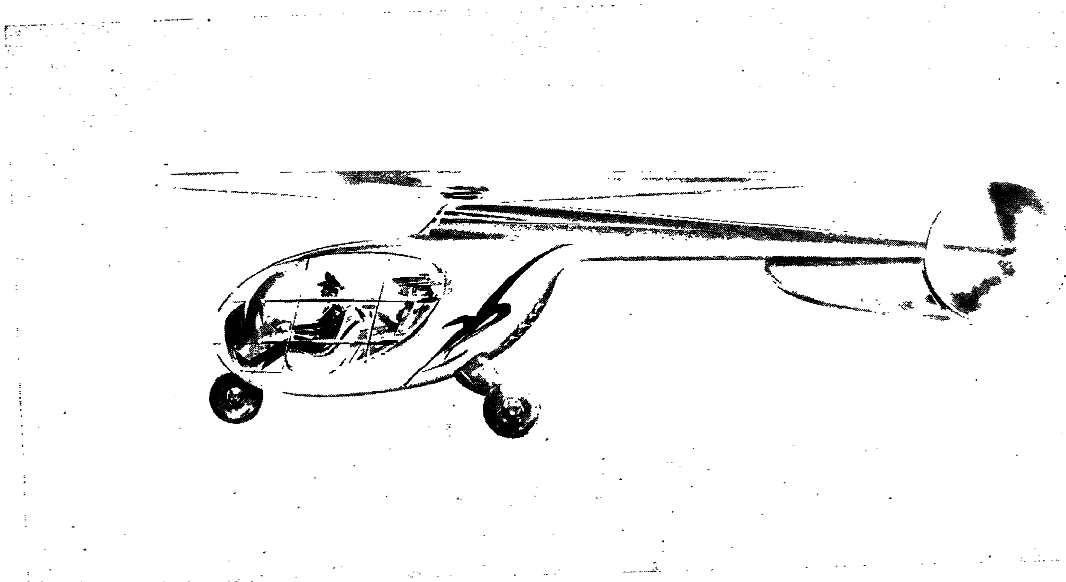
Further indication of the seriousness with which the future of the helicopter is viewed in responsible quarters was demonstrated by the request of the National Advisory Committee for Aeronautics for an appropria-

tion of $1,500,000 to expand its research activities in connection with the helicopter.

Evidence that the stage is even now being set for the enactment of the next scene in the unfolding drama of the air age lies in the caliber of men and the kind of money which already are piling the blue chips high on the helicopter card. Henry J. Kaiser, the great industrialist who has made such an outstanding contribution to the winning of the war by building Liberty ships, aircraft carriers and other vessels at unprecedented rates, knows full well that the vast shipbuilding empire which he has helped to create must come to a virtual standstill with victory.

He, along with other farsighted industrialists, does not want to see the skills of human beings go to waste and vast quantities of machinery, equipment and factories rust and rot, so he is exploring many avenues for the production of homes, automobiles, aircraft and other consumer goods of a high quality and low price hitherto undreamed of. He is associated with helicopter development at his Fleetwings, Inc., plant, at Bristol, Pennsylvania, and although admitting the helicopter was still in its very early stages, he predicted in 1943 that it would occasion tremendous industrial and engineering activity following the war.

Harry Woodhead, President of Consolidated Vultee Aircraft Corporation, announced in the summer of 1943 that his company was hard at work on a version of the



Helicopter design proposed for the future by William B. Stout, head of the Stout Research Division of Consolidated Vultee Aircraft Corporation.

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helicopter for the specific purpose of supplying a postwar market. Consolidated Vultee, one of the very largest producers of aircraft in the world, builds the famous four-engine Liberator bomber and cargo plane, the equally outstanding series of twin-engine and four-engine PBY series of Navy patrol boats, and other important warplanes.

Lawrence D. Bell, president of Bell Aircraft Corporation, has expressed the opinion that ultimately helicopter manufacture will be a "tremendous industry." He added:

"This won't come immediately because real development cannot start until after the war is won so far as commercial applications are concerned. The helicopter is important to the private owner because it will increase his scope; but I don't think it will put either the automobile or the airplane out of business."

Another newcomer to the autogiro-helicopter field is the Firestone Aircraft Company of Akron, Ohio, a subsidiary of the Firestone Tire and Rubber Company. In the summer of 1943 it announced the acquisition of G & A Aircraft, Inc., located at Pitcairn Field, near Willow Grove, Pennsylvania. With this acquisition, Firestone obtained a license from the Autogiro Company of America on nearly two hundred patents covering an extensive field of development of rotary-wing aircraft, including both autogiros and helicopters.

The G & A Company succeeded to the business of Pitcairn Autogiro Company, the original manufacturer

of rotary-wing aircraft in this country. Included in Firestone's purchase was the entire G & A plant and equipment. The company has delivered a number of autogiros to the British Government and has developed a new military autogiro for the United States Army. Details of design and performance of the Army model have not yet been made public.

I have already mentioned the large stake in the helicopter business, through its Sikorsky Division, of the United Aircraft Corporation, most widely known for its production of the powerful Pratt & Whitney air-cooled radial engines and the deadly 400-mile-per-hour Navy fighter, the Corsair.

One of the applicants proposing to inaugurate helicopter transportation services after the war is the Greyhound Corporation. It proposes just a little less than 50,000 miles of helicopter routes throughout the United States. It is fairly certain that the officers and directors of this successful and long-established transportation organization did not go to the time, expense and trouble involved without first making a careful and exhaustive investigation to determine the feasibility of this method of transportation in the near future.

The Burlington Transportation Company has asked for nearly 10,000 miles of helicopter routes. Here again there is no evidence of a starry-eyed dreamer or a wishful thinker on the crackpot fringe trying to jump the gun on Buck Rogers in 2000 A.D.

Northeast Airlines has asked for certificates authorizing it to serve all first- and second-class post offices, railroad stations and airports in Connecticut, Maine, New Hampshire, Rhode Island, Vermont and New York, covering a total of 407 points.

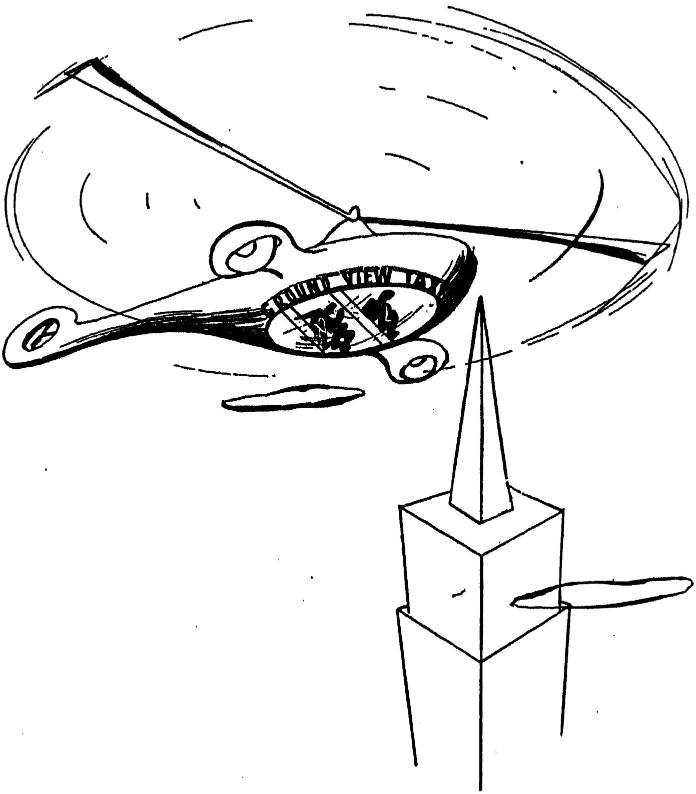
In many ways the application of Northeast Airways was most unusual of all. President S. J. Solomon filed the application shortly after he and other officials of the airline had witnessed demonstrations of the early Sikorsky helicopter by its inventor.

Solomon proposes that Northeast's helicopter system will augment the regular air mail operations of the airline. Mail and express would be flown not merely between the cities and towns but also from congested urban locations out to all principal airports for routing on mail-carrying airliners.

The application seeks authorization for the transportation not only of air mail but of all first-class mail. Thus Northeast's plan is the first specifically to bring to reality the transportation of all first-class mail by air and the first plan to utilize the extraordinary flight advantages of the helicopter. Moreover, as the helicopter service progresses, it is planned to request authority to carry passengers to and from downtown districts, airports and suburbs. This, if granted, would constitute the first aerial taxi service in history.

It would be next to useless even to attempt to provide

an appendix showing the complete list of applications, because it would be out of date before this book was



in print and such information can much better be obtained from current sources.

The vast amount of thinking, planning, engineering study and financing for helicopter development and

applications on a wide scale is not based on nebulous possibilities in the future but on hard facts and on clear-cut evidence of the present which builds an airtight case for the helicopter when it comes up for trial in the postwar era.

Learned scientific authorities are listening earnestly to serious papers on the problems of rooftop landings. Traffic representatives of big commercial airlines are giving serious study to the economic consequences of supplanting present airport-to-downtown limousine services with helicopter shuttle buses. In connection with the former, an actual rooftop operation, probably the only one in the world, has been conducted for several years by Eastern Airlines between the airport at Camden, New Jersey, and the roof of the Philadelphia post office across the Delaware River.

This service was pioneered by Captain John M. Miller of Eastern Airlines. The Post Office Department under a special act of Congress awarded a contract for the service early in 1939 to test out the feasibility of this method of transporting air mail more expeditiously from post offices in larger cities to the outlying airports.

A helicopter was not used, of course, for none was available at that time to perform such a service. The equipment used was a two-place Kellett autogiro with the provision for "jump take-off" previously mentioned. In this arrangement, part of the engine power is utilized to provide initial rotation of the main rotor.

This enables the autogiro to take off and land with a much shorter run than would otherwise be possible. Although this operation was conducted by the autogiro, it is well worthy of discussion because it represents a practical, time-tested commercial application of a rotary-wing aircraft on a job which will be done more efficiently by the helicopter in the future.

In addition to being a capable pilot, Captain Miller is an astute observer and proved to be a serious student of a great variety of problems involved in the new type of operation which he performed.

First of all, Captain Miller is on the record as having been bitterly disappointed over the architects' apparent lack of interest in aeronautical considerations which would make it safe to operate from the roof and the attitude on the part of certain Government officials who seemed to think that the whole idea was pretty visionary and hardly worth the effort. The result was a roof 162 feet above street level, 365 feet long and 247 feet wide, running the long way of the building. On either side were two penthouses 30 feet high.

"In other words," says Captain Miller, "flying operations are confined to a channel running north and south with 30-foot cliffs on the east and west sides made of stone and steel!"

With winds from the east or west the pilots cannot afford to make any errors in judgment, but in spite of problems presented by wind, weather and mechanical

difficulties, the service has averaged over 90 percent of schedules completed. The autogiro used carries, in addition to the pilot, 300 pounds of mail, and fuel sufficient for two hours' flight. The distance between the airport and the post office is only 6 miles, so the autogiro's cruising speed of 90 miles per hour and two hours' range proved ample.

Indirectly, Captain Miller made a couple of strong arguments in favor of the helicopter in analyzing the shortcomings of the autogiro for rooftop operation. For one thing he pointed out that much better performance could be obtained from the autogiro if it could be designed for increased rotor speeds in order to take off with a shorter run and increase the climbing angle.

Another serious shortcoming of present-day autogiros, he said, is their handling characteristics in high winds. The autogiro Captain Miller has been flying will normally take off with a full load in dead air with a take-off run of 250 feet under normal conditions. With a steady wind, the autogiro taking off into the wind generally has to shorten the take-off run, but he found that even with a light load it sometimes took a greater distance than the normal. This he ascribed to the turbulence of the air on the roof and he strongly urges that future designs eliminate sharp edges and obstructions above the level of the flight deck.

In these three respects the helicopter will have a great advantage. Its ability to rise vertically under full con-

trol eliminates the possibility of disaster through the take-off run being prolonged by any combination of unforeseen circumstances. Because of its high rotor speed the helicopter is less affected by turbulence, sudden gusts, up-drafts and down-drafts than either the autogiro or conventional airplanes. If air movement tends to carry it out of the line of flight chosen by the pilot, immediate correction can be made in any direction—up, down, forward, backwards or to either side. It is this characteristic, probably more than any other, which will give the helicopter such high utility value and will enable it to perform safely, surely and reliably under the most difficult circumstances. And the helicopter's solution of the second difficulty encountered by the autogiro eliminates the third. Much smaller roofs can be used for landing helicopters than could be safely employed by the autogiro as we know it today.

The autogiro constantly is being improved too, however, and enjoys the advantage of many more years of successful operation than the helicopter. Therefore it is entirely possible that we shall see rotary-wing aircraft in the future which are basically autogiros but have in addition improved provisions for power drive to the rotor so that they can compete more favorably with the helicopter with respect to controllability and hovering flight.

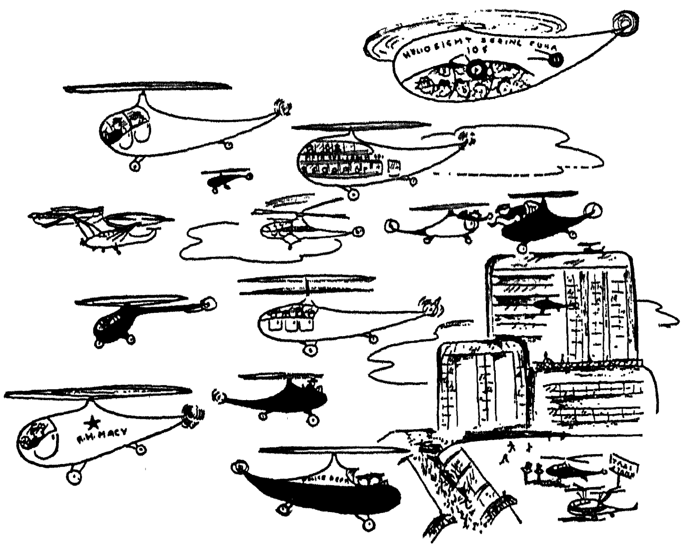
Architectural considerations are really more important than might be supposed. Aviation groups will have

to reach out aggressively to attract the interest of competent architects and assist in their education with respect to the streamlining of structures to create the minimum of obstructions to the smooth flow of air.

Spacious roofs probably will have structures along one side or at one end equivalent to hangars with folding or roll-back doors to provide shelter for helicopters. The edges of the roof will fall downward in a sweeping curve with perhaps an offset or guard rail below as a double safeguard to traffic below and the occupants of a helicopter in the event of accident. Where the roof space is limited and yet it is desired to provide accommodations for the storage and parking of helicopters, narrow ramps could be provided at the sides of the roof for descending and ascending craft. Another method which undoubtedly will be adopted in some instances is the use of elevators which rise flush with the surface of the roof, like those on aircraft carriers. The latter system would require the minimum of space because the top of the elevator actually would be used as a part of the landing surface when not in use.

These buildings of the future may even have slots and specially designed vanes to smooth out the air flow and decrease turbulence. Some of the architects with whom I have discussed these problems have been greatly intrigued by the new possibilities opened up for the introduction of new designs and decorative treatments in modern architecture.

Each landing-space will in the course of time require considerable equipment. A "must" item is some form of wind direction indicator. Smoke pots, such as are now used at some landing fields, may prove to be the most



satisfactory, for they can be installed flush with the landing surface and offer no obstruction whatsoever. Smoke pots also are somewhat faster by virtue of being more sensitive than wind socks or tees to slight or sudden changes in wind direction and velocity. A single smoke pot in the center of a small roof will give the helicopter pilot all the visual reference needed to correct for wind variations in landing. On large roofs smoke pots would

be located at the corners as well as in the centers. Such devices would not add to the smoke and grime of cities, however, for the chemical properties of the fuel would be such that the smoke would dissipate quickly without odor or residue.

Landing decks of any size will be equipped with control towers, two-way radio communication installations and some weather instruments. Where all-weather operations are contemplated, provision must be made for electronic devices which will accomplish safe, sure landings under the most adverse weather conditions. For night operation signal lights, floodlighting equipment, boundary lights and adequate warning lights on all adjacent structures or other hazards will be standard equipment. Here is another clue to what large-scale commercial and private flying can do for industry and the national economy. In a dozen years or less, a half dozen different industries will be employing countless thousands of persons to provide equipment for airports and heliports alone.

There will be a host of other problems to challenge the architect and engineer. In the colder climates, steam pipes or some other source of heat will be installed under the roof deck to melt snow and ice in the winter. The future will see an acceleration of the present trend toward using the exteriors of buildings for living purposes and recreation. In New York this trend has already been in progress for years. All over the metro-

politan area the number of gardens and play areas on rooftops is increasing year after year. A large proportion of new apartment dwellings and even office buildings provide roofs and terraces designed for a maximum of usefulness. Future buildings may incorporate elaborately landscaped gardens, play areas and outdoor restaurants around the landing decks or on terraces and setbacks just below the heliports. Ugly smokestacks, water storage tanks and elevator lofts will gradually diminish and tend to disappear as the years go by. Chemical methods or electronic apparatus, possibly both, very likely will be used to aid in keeping skies over the cities clear of fog and smoke.

In the early days of scheduled air transport, airline companies themselves operated expensive cars and limousines to transport passengers between the outlying airports and mid-city terminals. This system soon proved economically unfeasible and unnecessarily complicated the establishment of rates and fares. In addition the airline companies found that operating a taxi business was out of their line and interfered with the operation of their air transport services. So the airlines made contract arrangements with private bus companies and motor fleet owners to handle such services. The charges established were as reasonable as possible consistent with safe, prompt service.

The same general sort of ground service has existed since 1930. All of the airlines have consistently worked

with other agencies to improve equipment and highway facilities. But there nevertheless has been widespread recognition upon the part of airline operators that this time-consuming trip from mid-city to airport constituted a serious obstacle to the fullest utilization of air transport facilities.

One air transport authority estimates that each air passenger averages one hour spent in traveling to and from the airport on each trip. This is a full two-thirds of the time required to fly between New York and Washington, D. C. An air traveler flying between New York and Philadelphia, for example, spends more time getting to and from the airports at either terminal than he does in the air. Consequently, railroad express schedules compete very favorably with the airplane, although the latter vehicle travels three times as fast.

Since the major commodity marketed by the airlines is time, they are seriously handicapped in exploiting the market offered by air travel because as the distance traveled diminishes the number of travelers increases. Thus if the airlines can succeed by any method in reducing the time required to travel from metropolitan centers to airports, they can double their business almost overnight by attracting short-haul traffic.

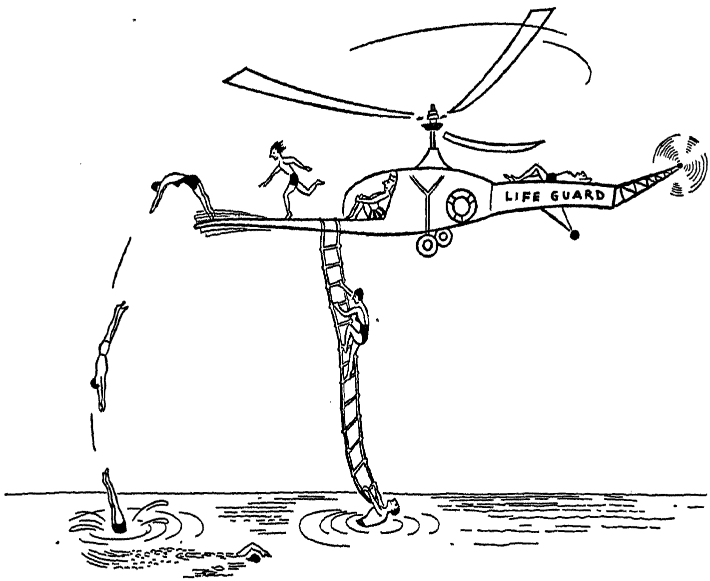
For these reasons enterprising airlines are eagerly watching the progress made in rotary-wing aircraft development and when satisfactory types are perfected will welcome the advent of the helicopter upon the

scene with cheers and jubilation rather than look upon it with scoffing suspicion and disgust as a potential competitor. Indeed it will be a competitor for certain types of services which the airplane could conceivably supply, but certainly no one form of transportation can hope to corner the market on supplying the vast diversity of man's traveling needs. Persons traveling between New York and Providence, Hartford, Albany, Philadelphia, Atlantic City, and so on, might very well prefer to travel the entire distance in one helicopter rather than hop from downtown to airport to airport to downtown when the difference of time between the two methods is not considerable.

There is an excellent possibility that steamship-to-shore service will be provided by helicopters at the world's great seaports. Despite the air transport optimists who maintain that transoceanic air carriers will take all the first-class passengers away from steamships, we can be fairly certain that surface vessels will carry increasing numbers of passengers for many years to come. Not only does the ocean voyage on the surface of the sea offer certain physical and aesthetic satisfactions which are quite different from those offered by the airplane, but it will be much cheaper for all those for whom time does not mean money. Enterprising steamship operators can conceivably cut a day off their schedules by providing for faster passage while the ves-

sel is still at sea to midtown customhouses at the ports of destination.

Actually, experiments have already been conducted in the pick-up and delivery of mail sacks from ocean



liners leaving and departing, and with the ability of the helicopter to land and take off safely from a small deck area, there is no reason why this service ultimately could not be extended to include passengers as well. Such a service could not help but be a powerful tourist attraction. Not only would the vacation traveler have a leisurely ocean voyage, but at the end of it would have

the equivalent of a free aerial sightseeing trip over the port of destination.

Here again is another example of how older established forms of transportation may use the developments in aviation to improve upon and make their services more attractive. The ship companies, railroads, bus operators, cab companies and truckers, all are going to adopt aerial vehicles and shape their capabilities to their own needs.

A great many airline operators and aviation leaders have long argued and are still arguing loudly that the operators and investors of companies who pioneered our truly excellent network of airlines throughout the United States, Central and South America and to all the continents of the earth are better equipped than anyone else to provide all future demands for air travel and, moreover, deserve to reap the reward of long years of unprofitable, unselfish investment of time and money. Such a stand is very shortsighted and impractical. First of all, if air transport is to achieve its full potentialities as quickly as possible, every transport company in the world and newcomers as well must participate in its useful application, and a criterion to determine who should be allowed to provide service is best established by asking the question: "Who can provide the safest service at the lowest cost, at the greatest convenience to the public served?"

Those airline interests who advocate a complete ban

against companies engaging in surface transportation entering the air transport field are working against their own best interests. For every steamship, railroad, bus, truck and other surface transportation company which engages in aerial transportation will find, serve and convert new customers to air travel and ultimately to the established airlines. Moreover, the existing industries can accomplish this in an amazingly short time, whereas it would require existing airline companies decades to grow and to reach and sell air travel to the same volume of customers.

There is hardly an industry, a business or any other activity of man which is not going to be influenced or served in some way by aviation. This is true of agriculture, the oldest industry of mankind. Already the conventional airplane has demonstrated valuable applications to agriculture. The agricultural use of the airplane known to everybody, of course, is crop-dusting. With powdered insecticide aboard and a special device for distributing it steadily from the bottom of the airplane, hundreds of acres of valuable crops can be sprayed in a single day to protect them against damage from insects. One man and one airplane can apply insecticide over a sufficiently wide area to justify the cost. Even in cases where sufficient hand labor could be assembled to accomplish the task, the time required might be so long that the work would prove in vain.

Crop-dusting has always been considered a hazardous

type of flying, for daredevils only. The excessive speed of the airplane and the desirability of releasing the powdered insecticide as near the ground as possible introduce the danger of striking trees, barns, telegraph poles or other obstacles such as silos or windmills which might be encountered in rural areas. The high speed and backwash of the propeller frequently result in an inefficient distribution of the insecticide.

Immediately the great advantages of the helicopter are apparent. It could fly at precisely one foot or ten feet over the tops of the trees or crops to be sprayed at any speed determined to be most efficient for the proper distribution of insecticide without any element of danger for the pilot. When a fence, telephone line or row of trees was reached, the pilot simply would fly up, over and down without danger or difficulty. The United States Department of Agriculture conducted experiments with autogiros and is anticipating the development of helicopters for a variety of applications to agriculture.

With the coming of the helicopter, the aerial traffic cop no longer will be a joke but a reality. It is well-nigh inevitable that traffic police will control certain areas from helicopters equipped with two-way radio and other signaling devices. The police department of at least one large American city already has conducted experiments in which a radio-equipped, low-flying autogiro was used to study the flow of surface traffic from

the air and transmit instructions to police officers on the ground so that they could route traffic around congested intersections over the least-traveled streets.

As an adjunct of local and state police agencies the helicopter would be particularly valuable in the case of natural disasters such as floods and hurricanes. In places where all wire communications and highways are wiped out and certain communities are isolated, airplanes have proved their worth in dropping needed food and medicine. After floods and winds have subsided enough to permit a safe landing, planes have also been used to carry in doctors and nurses and evacuate the wounded. Usually there is a considerable delay—measured in days—before airplanes can land and take off. While flood waters are still raging, however, helicopters could pick up stranded survivors from treetops, levees or roofs of houses and barns by lowering rope ladders or lassos. The helicopter not only would be able to deliver food and medical supplies, but could converse with places on the ground and transmit instructions by radio to faraway points.

The United States Forest Service will almost surely find the helicopter one of the most effective means yet devised to save our great forests from the ravages of fire. The helicopter could patrol wide areas and in combating fires could land fire fighters at the scene no matter how far removed from highways or suitable landing fields. Where fire fighters or other human beings were

in danger of being trapped by the conflagration, the helicopter would be able to evacuate them when no other means could possibly save their lives.

The airplane has proved its value in aerial mapping and surveying. Its high speed has been an advantage rather than a handicap in mapping large areas. There are many applications of aerial photography, however, where the helicopter will prove more suitable than the conventional airplane. This would be true of a detail survey of a canyon area. Another important consideration is that the helicopter could be used to determine the precise altitude of any landmark, whether it happened to be the stream bed in a narrow gorge or the peak of a mountain.

The picture with respect to helicopter buses, that is multi-passenger helicopters which will operate on schedules over specified routes as our metropolitan and intercity buses operate today, is not so clear. Some helicopter designers are talking about 50- or 100-passenger helicopters, although most of the practical thinking is in the terms of 6-, 8-, or perhaps 15-passenger units. But it is significant that bus operators see the helicopter as their logical counterpart in the air. The chances are very good that if it will prove feasible to build a 15-passenger helicopter, it will then be possible to build one twice as large. But if there are inherent limitations in helicopter design which would make large units impractical, the

employment of helicopters for bus-type services would be greatly restricted.

One application which immediately suggests itself is a regular service in outlying communities where homes or farms are widely spaced and surface roads are non-existent or extremely circuitous. Small landing areas would be provided at suitable intervals and the helicopters would stop only to discharge passengers or when hailed.

CHAPTER VII

THE HELICOPTER AND YOU

THERE are three vitally important considerations for every prospective individual purchaser of any private conveyance. They are, first, everyday use, second, safety of operation and third, initial cost and upkeep. We have seen that the private airplane failed miserably to reach a market of any significant numbers because, although it came very near to satisfying the second and third requirements, it came nowhere near meeting the test of everyday usefulness.

The helicopter meets the test of usefulness because it overcomes every one of the obstacles which stood in the way of successful utility for the conventional airplane —elimination of the need for an airport, secondary transportation between the airport and final destination, and special storage space and facilities when not in use.

Obviously the helicopter will not meet the test of everyday usefulness under circumstances where 90 percent of the travel of an individual by private conveyance might be entirely within vast and congested areas in which helicopter landing and parking spaces could not be provided except at prohibitive costs. Under these

circumstances, ownership of a helicopter would be luxury. It could not be used day in and day out, and for economical storage probably would have to be kept on the periphery of the congested area and used for longer trips on Sundays and holidays. But do not make the mistake of comparing this with a conventional airplane kept at an airport. The distance involved would be about one-twentieth or one-fiftieth as far as the plane owner would have to go to use his secondary luxury transportation. The situation is more nearly analogous to the man who lives in a city apartment, rides a bus or streetcar to his work and keeps his car in a public garage within a few blocks of his residence. The helicopter will require a somewhat larger storage space, but probably not more than twice the length of an average automobile because the rotor blades will be hinged and folded out of the way when on the ground.

Some designers and manufacturers are talking very confidently of "roadable" aircraft, that is, an aircraft with provision for removing or folding wings or rotors and driving along the highway like an automobile. Such vehicles are coming, certainly, but the aerodynamic and engineering problems to be overcome are so numerous and complex that this would seem to be a development we should not anticipate for a decade or so. Limited roadability can and probably will at the very outset be incorporated into most helicopter designs.

In an emergency the helicopter pilot would be able

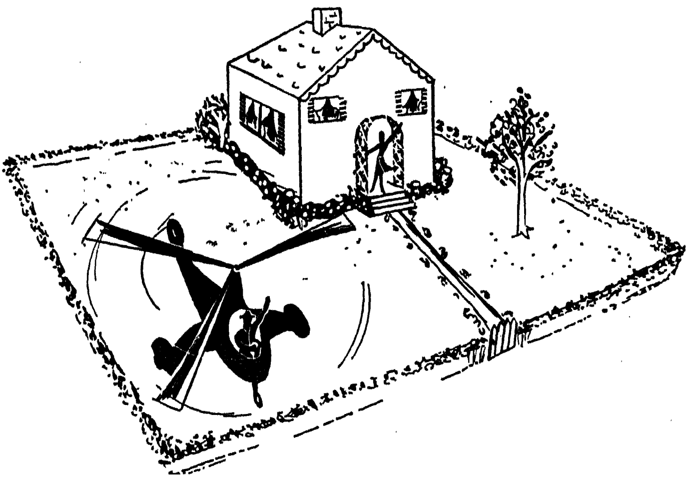
to fold his rotor blades back and drive down the highway with long rotor blades trailing along behind, but this would be a slow and awkward vehicle indeed to introduce on a modern highway. No, the helicopter can be a good flying machine and a poor surface traveler. And if an attempt is made to render the rotor detachable and to give the helicopter good performance on the highway, it will be a poor flying machine, and more likely poor everything.

As soon as we go beyond the persons who live and work entirely within a continuous congested area, the helicopter enters the competition unhandicapped by any restrictions determining everyday usefulness. Suburban home owners whose plot of ground can provide a landing area 40 or 50 feet in diameter will, within a very short space of time after the war, be able to travel to and from their work daily and use the helicopter for pleasure and recreation as well.

In suburban areas where individual plots are not large enough or otherwise not suited for safe helicopter landings, each neighborhood could very well set aside a small area for the purpose. Owners then could enlarge present garages or build new structures to shelter the helicopter and taxi down the street the few blocks necessary to reach their neighborhood heliport.

Such a project would involve no large expenditure. No control tower or radio installation would be needed, since the light local traffic would be governed by suit-

able traffic regulations. Lights with a little more brilliance than ordinary street lamps would be adequate for night operation, plus a few marker lights on any near-by obstructions. The cheapest kind of surfacing



would do satisfactorily and where traffic was light good sod would be perfectly all right.

It is entirely probable also that in the early stages of transition to universal helicopter transportation the helicopters would be permitted to taxi along the streets to regular established filling stations for gasoline, oil and mechanical adjustments. As the months and years go by, specialized service stations catering to the needs of the flying fraternity will spring up adjacent to heliports and small neighborhood landing areas.

We hope, however, that the architectural styles adopted by the future chain owners of helicopter service stations will be greatly improved by virtue of the horrible examples we have with us today. There is no law of man or nature which dictates that these purveyors of petroleum products must invariably hawk their wares from architectural eyesores. Communities everywhere might very well take a tip from the beautifully planned parkways of New York State and insist that these travelers' rests of modern times be in keeping with the spirit and architecture of the surrounding community.

So it is not unlikely that helicopter owners within a reasonably short while will be able to go nearly every place that they could go by automobile, plus doing hundreds of things that automobilists could not do. The time is not so far distant when many persons will want to own a helicopter first, then acquire an automobile as a convenient adjunct for surface transportation when they can afford both.

At first thought the prospect of aerial traffic jams and great numbers of helicopters whizzing up and down, sidewise and past each other at 150 miles per hour may be completely terrifying.

If so, stop and consider objectively for a few moments just what you do in your automobile nearly every day of your life. Countless millions of motorists pass

each other head on, on narrow highways at combined speeds of at least 100 miles per hour every day with no more than a few feet of air between them. Now, if that same trick were done in an arena, with thousands of spectators looking on, it would immediately become a breath-taking daredevil spectacle.

But we have learned to rely implicitly on the driving judgment of our fellow highway users. In normal times when cruising down the highway at 60 miles per hour, approaching cars traveling at equal or greater speed whiz past us hour after hour and we never give it a second thought. Considering the perversities of human nature, it is nothing less than miraculous that we do not have far more head-on collisions than now occur.

Only a few states in the entire country have laws requiring that brakes, headlights and other safety devices be properly inspected at regular intervals to insure their being in proper mechanical condition. Consequently every single highway intersection and sharp curve that you pass is a potential source of death and destruction. Take the laxity with which highway rules established for reasons of safety are obeyed and enforced, add alcohol and stir briskly with one-arm driving, and it is small wonder that thirty to forty thousand persons are killed and a million injured in motor vehicle accidents on the streets and highways of America each year.

In the helicopter, visibility is excellent in all directions. There can be no blind intersections where vehicles

approach a given point at the same instant, for there is nothing to limit detection of all other craft within miles except dirty weather and darkness. When you desire to fly under such conditions, the helicopter will be privileged, perhaps compelled, to stick to the regular aerial highways. This may sound a little mysterious at first, but it will become just as natural to the average American as it is to obey traffic signals and follow highway markers automatically.

Radio and its sister science, electronics, will provide the means of flying through absolute blackness or densest fog without the least danger of colliding with other aircraft in the sky.

Electronics is a science which makes the very hush-hush radar detection apparatus possible. Our scientists have begun to harness the ultra-short waves of the radio spectrum. The ultra-short wave radiations of electrical energy, unlike the longer wave lengths used for regular broadcasting, possess the property of traveling in a fairly direct path and can be focused and projected in a beam similar to the manner in which light is focused and projected by a searchlight.

Imagine that you own a helicopter and fly into the city from the country every day. At the end of the day you leave your building to discover a raging blizzard has come up during the afternoon and has almost paralyzed traffic. Going to the near-by heliport you check

in at the control tower and learn that all flying in the control area is prohibited except "on instruments."

Being assured that the gale is not of hurricane intensity, you decide to go on home for dinner. First you announce your "flight plan" to the traffic control officer, giving him the exact time of departure, your destination, the route to be followed and the rate of speed at which you will travel. You will also indicate the altitude at which you will fly. This will be governed by existing traffic control regulations.

When the helicopter is rolled out and the motor "revved up," you engage the clutch and take off at the specified time, ascending straight up to the predetermined altitude. When that altitude is reached, you will face the helicopter in the proper direction by referring to the compass and start accelerating until you have reached the cruising speed specified in your flight plan. Within a very few seconds after starting off on your compass heading, you pick up the leg of the beam. This peculiar jargon of the pilot merely means that you will fly parallel to an invisible beam directed at your next destination. This will be accomplished by means of an instrument showing you at all times your position in relation to the radio beam.

Imagine, for example, an instrument on the dashboard with a broad white line down the center. To the right of it is a narrow illuminated vertical line which wavers from side to side. If you turn the helicopter slightly to

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Imagine, for example, an instrument on the dashboard with a broad white line down the center. To the right of it is a narrow illuminated vertical line which wavers from side to side. If you turn the helicopter slightly to

your left, the illuminated line will also move to the left as you approach the center of the beam, which is represented by the broad white line in the center of the instrument. In order to keep on the right side of the road, so to speak, you then turn back to the right and watch the vertical illuminated white line until it is in the correct position. If you persisted in steering to the left until the vertical illuminated line crossed the broad white line in the center and entered the space to the left, your action would be equivalent to crossing the white stripe down the center of a highway and you would be in danger of meeting an approaching aircraft head on.

On the other hand if you steered to the right of the vertical illuminated line and it disappeared off the face of the instrument to the right, you would be "off the beam" and likely to get lost unless you promptly returned to the airway.

Meanwhile you would be watching your altimeter to maintain the proper height so that you would be in no danger of getting in the way of or overtaking other aircraft which might be flying at different levels.

At certain intervals along the airways, a little signal light on the dashboard would light up indicating that you had passed over a marker. Either the flashing of the light or an audible signal would identify the marker so that you would know exactly at what point along the airway you were flying. At certain points along the way you would switch on your transmitter and notify traffic

control operators of the point you had reached along the route. If due to unforeseen wind changes you were lagging behind the schedule established in your flight plan, you would increase your cruising speed slightly to correct for it by the time the next fixed point was reached.

You would also be watching your air temperature indicator and humidity very closely for signs of icing conditions. Instruments have been developed which warn pilots when ice begins to form on any vital surfaces of the aircraft. If icing conditions were encountered, the pilot would simply turn on the de-icing mechanism, which would keep the rotor blades and controls free of ice.

Now you have flown about fifty miles and have reached a point where you must leave the airway and find your own back yard in the blizzard and darkness. You so advise the traffic control operator by radio and descend to a lower altitude to pick up a local beam which goes off at right angles to the main airway. At the lower altitude you turn your helicopter 90-degrees to the right of the compass setting you have been following and in a moment the illuminated vertical line shows up to the right of your instrument. In a few minutes more a marker signal identifies the village near which your home is located. From experience you know you must fly two minutes beyond this point to reach

the lighted highway which branches off towards your neighborhood.

Descending very slowly you watch for the lights. Soon you spot them blurred by the scurrying snowflakes and continue flying along slowly over the highway until you reach the familiar landmarks near your house. You turn on your own landing lights and proceed cautiously over the familiar landscape until you spot the light shining in your house. In a few moments you have landed, put the helicopter away and are warming your hands in front of the fireplace.

What would have happened if you had got lost, either through some error on your own part, or because of defective instruments or radio? We will assume that you suddenly discover that you are off the beam. Your compass heading is still in the right direction, but you have somehow wandered off the aerial highway. You feel very certain that the needle did not cross over the broad white line into the left-hand sector of the instrument and in addition there has been a strong wind from the west, so you reason that you may have been blown by a sudden increase in wind velocity to the right of the airway.

Under more favorable circumstances, you probably would then make a 90-degree turn to the left and proceed for a half minute in an effort to pick up the airway again, but under such severe weather conditions

the soundest course of action would be to bring the helicopter to a stationary position immediately and ask airways traffic control for your position by radio. If a strong, steady wind was blowing, it would be best to head into the wind and proceed at an air speed equivalent to the last reported wind speed in order to maintain a fixed position in relation to the earth. The radio conversation might go something like this.

"Helicopter N-435-2A calling Airways Traffic Control RT."

"This is ATC-RT, answering. Go ahead, helicopter N-435-2A."

"Proceeding flight plan 46 New York to Peekskill but have lost radio beam, please give me position. Passed marker 32 at 18:02. Now heading due west, air speed 30 MPH."

"Wind has shifted. Change your course to northwest and maintain air speed of 22 MPH. Continue broadcasting your call number until you receive further instructions."

You continue repeating steadily, "NH-435-2A, NH-435-2A," and so on, until in a few moments the traffic control station breaks in.

"Your position is two miles east of airway, opposite marker 33. Increase speed to cruising, change compass heading to northwest by north; advise us when airway is intercepted."

This plotting of your position was accomplished by

several traffic control stations at widely separated points taking directional bearings on your radio transmitter as you broadcasted. Lines were drawn on a map immediately in the direction from which each station received your signal. The point of intersection of the three lines indicated your exact position.

After proceeding a little over a minute at cruising speed, the needle on your airway indicator comes to life and as it gradually swings over towards the center line, you shift your course to the right until the needle remains stationary at the proper place on the dial. Switching on your transmitter again, you advise traffic control that you have intercepted the airway satisfactorily and are proceeding on it at a speed of 100 miles per hour.

Since you are running behind the schedule of your original flight plan, you decide to notify your wife so that she will not be unduly concerned about your arriving late. Reaching into a compartment on the instrument panel, you remove a telephone hand set and dial your home telephone number. In the years to come, it will be a common thing to install personal radio-telephones in private aircraft and automobiles, just as we have ordinary 'phones installed in our homes and offices now.

Not only will the homes of helicopter owners be equipped with signal lights to make them more easily discernible in storm and darkness, but it is not unreasonable to anticipate that they will in some instances be

equipped with their own local radio beam or marker. This would be particularly likely in sparsely settled communities. Private radio directional equipment would be on individual frequencies to avoid interfering with the publicly operated airways or confusing other pilots.

Now let us consider your plight in the event that the radio equipment had failed. You would then have descended to an altitude of about 100 feet above the ground level of the local terrain, as indicated on your map. Turning on your landing lights, you would continue descending, very slowly, watching carefully all around you to make sure there were no high-tension wires, trees, or other obstructions in the vicinity. As soon as you saw some object you would come to a halt until you had ascertained the nature of your surroundings. As soon as you identified some object beneath you, you would literally feel your way across the field or forest, holding a steady compass heading until you reached a highway, railroad or other identifiable landmark.

If you came upon a highway, for example, you would follow it to the first intersection, then descend and read the signposts with your spotlight and know precisely where you were. Since it would be dangerous to proceed unnecessarily without radio in such weather, you would simply fly along over the highway until you came to the nearest village or town where you could

get repairs or put the helicopter up for the night. You would telephone airways traffic control immediately, advising them of your whereabouts and canceling your flight plan. This is really what happens to any motorist when weather, fatigue or difficulty with his car makes it impossible to proceed.

Next, face the most serious difficulty which might confront you—engine or other mechanical failure making it impossible to continue flight. If that should occur, you would move the lever governing the pitch of the rotor blades to a setting which would provide the most efficient flight with power off. (Or, the pitch change might be automatic.) In this condition your helicopter would become an autogiro. That is, the upward rush of air caused by the sinking of the aircraft would cause the rotor to continue revolving in the same way that the windmill revolves as the wind blows against its blades. However, the aerodynamic characteristics of the rotor would create a certain amount of lift also, so that the rate of descent would be within safe limits.

The controls still would be in operation and the rate of descent could further be reduced by descending at an angle to the ground instead of coming straight down. At the time of engine failure you would have known your position within a few hundred feet. Quickly referring to your map you would pick out the best area in the neighborhood for an emergency landing and glide in that direction. Your next step would be to

turn your landing lights full on and radio Airway Traffic Control of your emergency landing. Meanwhile you would watch your altitude closely in order to slow your forward speed as you approached the ground.

If you had the misfortune to descend into a big grove of trees or a group of closely spaced buildings, you might very well sustain injuries ranging from minor to serious. But with a well-designed cabin and barring freak accidents, injuries to be anticipated in such a crash landing would be far less tragic than those suffered in highway accidents when two or more automobiles collide at high speeds.

Normally your chances of making a safe emergency landing on a field, hillside or highway probably would be better than 100 to 1. You would then radio Airway Traffic Control that you had landed safely. If you could not immediately identify your surroundings, Airway Traffic Control could plot your position by radio, as described before, and tell you in which direction to proceed to the nearest highway or habitation. If refuge were not very close by, Air Traffic Control would advise you to remain in the protection of your helicopter and send another helicopter out to pick you up.

Such a rescue craft would be equipped with a radio direction finder, so that by leaving your radio transmitter on, it could fly directly to your position, even if your lights were not visible from the air.

In the event of an emergency landing, where you did

not advise Airway Traffic Control of your safety because of injury to yourself or to the radio equipment, Airway Traffic Control would dispatch searchers to the area to find you and lend assistance. Such a search probably would be conducted by local police officers and citizens in co-operation with Airway Traffic Control. But most likely all aircraft in the future will be equipped with automatic "SOS" transmitters. Such a device consists of a compact short-wave transmitter built to withstand almost any conceivable impact. It is adjusted so that a severe jolt such as might be caused by a crash will set it in operation. Automatically, then, it sends a continuous distress signal for a specified number of hours or until the batteries wear out. Thus the scene of the accident could be located from the air almost immediately, without any necessity for tedious search by ground parties.

You may wonder about the danger of aerial collision between helicopters and other aircraft traveling in great numbers along the airways under conditions of zero visibility like those described in the foregoing. First of all, the intervals of space involved are measured in hundreds and thousands of feet, instead of three, four or a dozen feet. When aircraft are whizzing in opposite directions along either side of their aerial highway, there is a thousand feet or more between wing tips, not just three or four feet between fenders as is the case on a great majority of our highways.

Aircraft traveling in the same direction would be instructed to proceed at identical speeds and would be spaced behind each other, providing an adequate margin of safety.

As each craft is reported passing successive radio markers, Airway Traffic Control operators would have a constant check on whether the proper intervals were being maintained. If any pilot advanced or lagged too much, he would be instructed to increase or decrease the speed appropriately. In addition, all aircraft eventually will probably be equipped with warning devices which would reveal when any other aircraft came within, say, one thousand feet. Such an instrument might also be made directional and show constantly how many feet away the other aircraft was after it once came within the range of the instrument.

You would then be able to determine whether another aircraft was approaching head on, overtaking you from the rear, approaching from the side, above, or below, and maneuver accordingly to evade the other craft. Such an elaborate form of the instrument may possibly be too heavy or too expensive for the small private aircraft, but it will certainly be available in some form satisfactory to meet safety requirements.

A total failure of the main rotor of a helicopter would mean complete loss of support and the craft would plummet to earth from whatever altitude it happened

to be at when the failure occurred. It is possible to design and construct rotor blades and pitch-control mechanisms so that the chances of disaster from structural failure or inherent weakness of materials would be infinitesimally low. So far the safety record of the helicopter has been extraordinarily good for a radically new type of aircraft.

Collision of the rotor blades with any structural part of another aircraft in flight would be likely to result in partial or complete destruction of the rotor. I doubt if there is sufficient test data to determine accurately the effect of birds or large hailstones on rotor blades. The rotor blades are traveling at terrific speeds—from 270 to over 300 miles per hour at the tips. The blades probably would knife through birds without difficulty, but hailstorms would call for precautionary landings.

Personally, I am in favor of further study of the practicality of huge parachutes as reserve safety equipment for private aircraft. Such a 'chute would not be worn, but would be packed in a compartment and released in an emergency to lower the entire craft gently enough to avoid serious injury to its occupants. Strong, giant 'chutes have been developed which drop field pieces, jeeps and so on. If produced in sufficient numbers the cost might in time be brought within reasonable limits.

This provision would safeguard helicopter passengers against almost any eventuality except violent accidents during the couple of hundred feet between take-off and

the effective height at which the 'chute would operate satisfactorily.

But the greatest safety insurance of all against collision is the unlimited space of the realm of the air. The design of aircraft up to now, particularly military aircraft, has left much to be desired in the way of visibility. Poor visibility alone has been the cause of many tragic accidents in the past.

Postwar designs of private aircraft will see this defect largely remedied. This will be accomplished not only by changing the arrangement of structural elements of aircraft, but by utilizing newly developed transparent plastics which are strong, light and eliminate nearly all distortion of vision.

The third important factor limiting the widespread acceptance of private-owner aircraft was high cost—operating and maintenance costs being greater deterrents than the first cost. The experience now being acquired in quantity production of aircraft, while not aimed primarily at reduction in cost per unit, is nevertheless achieving that result. The manufacturer of one of our important fighter planes was spending 32,000 man-hours on the construction of each plane before the war. When the first quantity orders were received the tooling was increased and the figure was reduced to approximately 16,000. Then when the United States entered the war and production schedules were tripled and quadrupled,

the company finally reduced to 7000 the number of man-hours required to complete each plane, or less than one-fourth of the original figure. Aircraft instruments and parts which a couple of years ago cost hundreds of dollars each, now can be made for only a few dollars.

The net result is that the aviation industry possesses on a fully adequate scale all of the elements necessary to start competing with Detroit in the mass production of transportation units.

Another demonstration of how quantity production decreases the cost of the finished product was contained in a report issued by the Aircraft War Production Council in the fall of 1943. It stated that since January 1940, Pacific Coast plane factories increased production more than forty times on a weight basis, while employment increased less than tenfold.

In building fighter planes, the report continues, only 5 men are needed now for every 100 required three years ago to build the same number of planes. This simply means that only one-twentieth as much labor is required today to build a given airplane as was needed three years ago.

Labor is the major item of cost, with a few exceptions, in the manufacture of any product. In aircraft production, engineering development costs are extraordinarily high in comparison with other transportation industries. Consequently, for some years, or until aircraft become relatively as standardized as present-day automobiles,

these costs must be met through higher prices of individual units to the buyers.

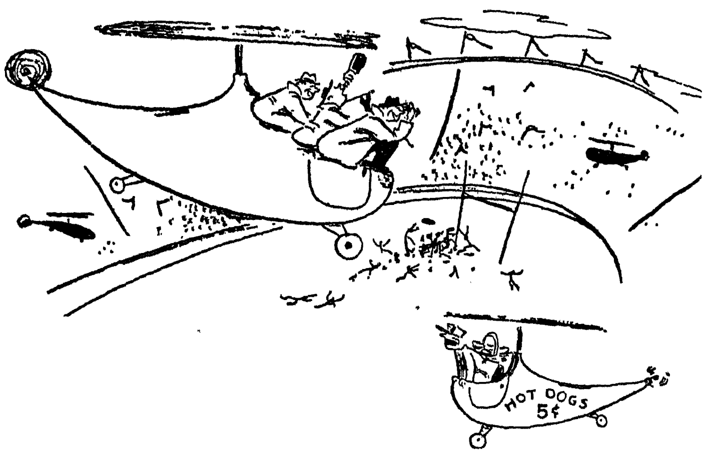
Companies with vast capital resources will be able to absorb the development costs over a long period of years, enjoying a substantial advantage over smaller organizations with more limited financial resources. To stay in the running, the latter will have to concentrate on exceptional quality of products and services, along with highly efficient management techniques, to offset the competitive price disadvantage.

For some companies, both great and small, the government is necessarily and properly paying for and thus absorbing considerable costs of engineering development; for there can be no absolute guarantee that contracts being performed for the armed services will result ultimately in profitable products for commercial sale. This consideration applies to all kinds of businesses in wartime and is not limited to the aviation industry.

The cost of engineering development is a particularly large item in the helicopter business at this stage. Some competent authorities believe that in the initial phases of helicopter development, these costs can more feasibly be absorbed by existing transportation agencies who propose to utilize helicopters for certain types of services. My own conviction is that sufficient demand will exist for private helicopters to eliminate the necessity of waiting until the application of helicopters to com-

mercial transportation has absorbed the bulk of developmental expenses.

Materials required for the fabrication of the product constitute another major item of cost. Not so many years ago aluminum was a very rare and expensive metal.



Despite increasing taxes and wages, the cost of aluminum ingots has steadily decreased during the past several years, while total production has doubled and redoubled. Economies effected through improved methods of fabrication and elimination of scrap and waste are further reducing the cost of aluminum in the finished product. Aluminum has become a major metal.

Magnesium, which until a few years ago was hardly more than a curiosity in the laboratories of scientists, is now universally used in the construction of aircraft.

Magnesium is much lighter than aluminum and is only about one-fifth the weight of steel. During World War I, it sold for about five dollars per pound. Today nearly a half ton of it, on the average, is going into every fighting plane built. And measured on the basis of bulk, it is cheaper than aluminum.

The source of magnesium is most interesting. Most of it is being obtained from sea water by a chemical process. It seems almost impossible to believe that the salty liquid in which we bathe at the seaside yields up a strong, light structural metal, which rigidly carries tons of stresses in aircraft structures and their engines.

Then there are the vast new fields of synthetics and plastic-bonded plywoods. Wood, one of the oldest of man's structural materials, is being sawed, sliced, shaved, even blown to smithereens in pressure tanks, and then combined with chemicals and synthetics to make an infinitely variable new structural substance. Wood is cheap and plentiful and methods of fabricating plastic-bonded plywood lend themselves readily to low-cost, fast production of identical items.

One of the most successful fighting planes of the present war, the British DeHavilland Mosquito, is fabricated of plastic-bonded plywood. Designed originally as a medium bomber, its performance proved so phenomenal that it is being used for a dozen different types of missions with suitable modifications in armament and so on.

With evidence before us of these amazing reductions in costs of labor and materials, who but the most unseeing and uncomprehending pessimist can dare assert that we will not have private planes and helicopters with full instrumentation and radio equipment for around the cost of a medium-priced car within a few years after the war is ended?

Cost of operation and upkeep may indeed be higher at the outset than we could wish for, but these will quickly fall into line too. The improvement in fuel for internal combustion engines has been so great during the war years that automobiles designed around improved engines to take advantage of the newer gasoline will travel nearer 50 miles per gallon of fuel than the present 15 to 20 miles per gallon. This is doubly important in the case of aircraft, because with an equivalent increase in mileage the weight of fuel required to travel a given number of miles is reduced by more than half.

Before the war, trained aircraft and aircraft engine mechanics were relatively few. With more than two million workers employed in the aircraft industry, plus the hundreds of thousands of expertly trained aviation technicians of the U. S. air forces who will be demobilized after the war, there will be no scarcity of mechanics to service and repair aircraft in any numbers.

In addition, some help or inducement from the Federal Government may be counted upon to assist in keeping operating and maintenance costs low. The active

encouragement of new industries, particularly new modes of transportation, has long been a consistent policy of the United States Government. In view of aviation's extreme importance to the national defense and to the national economy, both outright and indirect financial assistance are not only fitting and proper, but essential to the national welfare.

CHAPTER VIII

SOCIAL IMPACT

HELIPARK, U. S. A.—an imaginary community of the future. Not the too far distant future, but the future of five, ten or fifteen years hence, which will be upon us before we know it. This glimpse into the future is not visionary in the sense that it represents what one individual wishes for or hopes to see at some future time, but is rather a description of the logical consequences of actualities which now exist or are coming into being.

In Helipark there will be no streets or roads, only pleasant walks and pathways. Service drives for the occasional delivery or removal of very heavy objects will exist, but in all probability will be camouflaged or partially concealed. In some instances communities will grow around a small airport or landing strip with a concentration of commercial establishments, including servicing facilities, and recreational activities around the airfield. In other cases residents will forgo the landing field to enjoy greater freedom from commercial activities near their home; less noise and outside intrusion and so on.

Children and adults may play and roam at will over the surrounding country without fear of speeding trucks and autos. Arriving and departing helicopters present no problems because they land so slowly that if a child darts out into a helicopter's path the pilot can simply touch his controls and bounce back up into the air a few feet until the way is clear for an unobstructed landing.

A suitable roof deck may be used for landing the helicopter wherever it is desired for architectural considerations or because of the lack of a suitable spot on the adjacent terrain. However, in most instances it probably will be more economical and generally more satisfactory to use a portion of the lawn or other land near the house as a landing spot. The latter might also prove to be preferable from the standpoint of safety considerations, for in the case of roof-deck landings, unless the area was quite large there might be some danger of mishap in gusty weather or under conditions of high winds which might set up unexpected currents in the vicinity of the house.

The actual surface area upon which the helicopter lands is unimportant except that it must be free of large obstructions such as boulders, fences or extremely steep slopes which would prevent the helicopter from resting horizontally. The Army's Sikorsky XR-4 helicopter, whose rotor sweeps a circle 36 feet in diameter, has made numerous landings and take-offs from a 20-foot-square platform. The more important consideration,

therefore, is that adequate clearance be allowed for the rotors. Great care will be demanded of future helicopter pilots to insure that the rotor blades will not tangle with a clothesline in the back yard, radio aerials or masts, or even projecting eaves of the roof.

However, people will automatically become aware of and watchful for such things, just as automobile drivers now watch traffic signals, avoid pot-holes in the road and cross railroad tracks warily without even consciously thinking about it.

You can readily imagine the helicopter owner of the future cautioning Sonny not to construct antitank barriers or string barbed-wire entanglements across the landing spot when playing blitz with little Jimmie Jones, the neighbor's boy.

Helicopter garages will become an integral part of the home plan, just as a car shelter is taken for granted now. Even greater flexibility will be possible than in the case of the automobile garage. It may be under the main part of the structure; on the ground level but within the main walls of the home; on the roof; or merely an adjacent structure with a connecting path or passage. The future will most assuredly see also a great many combination structures designed to shelter a helicopter and an automobile or a helicopter and an airplane, or perhaps all three. And where it will all end nobody knows—probably with a space for Junior's rocket speedster too.

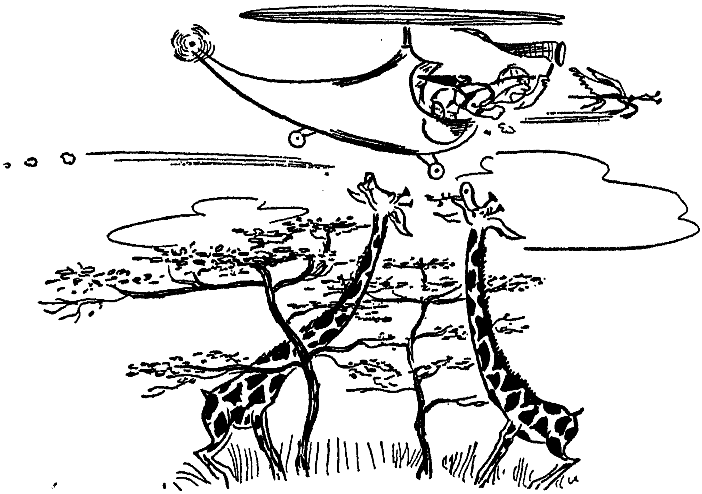
In flying communities where there is no need for level

asphalt or macadam streets, less grading and destruction of the natural contours and beauties of the land will be required. This will hold great economic as well as aesthetic benefits for future home builders. All of these factors which tend to decrease the cost of property and its preparation for use as a home site will mean a lowering and a broadening of the economic base at which families can afford to own their own homes. By the same token, those in higher income brackets can enjoy better homes and furnishings than would be possible otherwise. Assume that Joseph Jones, a skilled worker, a small businessman, or a member of one of the professions, who sold or stored his automobile with the advent of gasoline rationing, decides to investigate the possibility of investing in a helicopter or family plane after the war instead of another automobile. Thinking of the days before Pearl Harbor, Mr. Jones reflects that the automobile had in many respects ceased to be a means or source of pleasure. On those Labor Day and other summer weekends when the family most wanted to travel and enjoy a carefree holiday, traffic congestion often was so great that it took most of the joy out of the expedition for driver and passengers.

This would be true for nearly all of the great centers of population, though not necessarily applicable to small towns and rural areas. He reflects that congestion in surface traffic will continue to grow in the years to come rather than to diminish. And besides, over the years he

and his family have explored most of the interesting places and routes within a comfortable radius for Sunday or weekend drives.

So he considers the interesting possibility of doubling or tripling the radius of travel and the fascinating pros-



pect of visiting places hitherto entirely inaccessible by conventional means of surface transportation. If Mr. Jones were a resident of one of the Middle Atlantic states, he could look forward to visiting Florida, Lake Michigan or Canada on a long weekend without the tiring, nerve-racking strain which is inescapable on long motor trips.

Like most Americans, Mr. Jones prefers plenty of green earth and trees around his home if he can afford

it and if he finds such a place convenient to his work. The modest home he bought when first married is getting too small for a family of four and provides no possibility for expansion if the family grows. The neighboring houses are crowding close and the street has lost its suburban atmosphere as the community has grown and expanded around him. And along with increased costs of maintenance and repair on the house as the years go by, taxes and assessments are increasing. Of course he could move a couple of miles farther out in the smart new subdivision, Crestwood, but still he would have to pay very much more for everything—house, land, taxes and so on—and he feels that he would still be far from getting better living for himself and his family in any decent proportion to the increased cost.

First he decides to look beyond the normal commuting radius to find a location where acreage and natural scenic beauty can be bought for a small fraction of what it would cost in any sizable community. For his two children, both attending grammar school, one requirement would be a location within reasonable distance of a school. This should not be too difficult in most parts of the United States, even though it might be somewhat more inconvenient for the children than it would be for city dwellers. Any disadvantages caused by mere inconvenience should be far outweighed by the healthful, free outdoor living.

In building a home under these circumstances, it

should be kept in mind that cost of construction, including labor and materials and so on, will prove to be considerably less in small communities and rural areas than in the towns and cities. These savings, along with cheaper land, can be translated into a better home with more land and also applied to the cost and upkeep of a helicopter, which we are assuming is required to make this combination a reality.

In choosing his location, of course, Mr. Jones naturally wants to be near enough to other families so that new community friendships can be made. He would also be likely to select an area which would attract both old friends and new neighbors to a similar way of life. Mr. Jones's home could be anywhere from 15 to 75 miles from the town or city where he works daily. On the basis of engineers' predictions for the performance of the helicopters of the immediately forseeable future, this would mean a total elapsed time from home to office of roughly 15 minutes for the shorter distance to one hour for the longer. It is safe to take it for granted that helicopter landings will be possible within 5 to 10 minutes' travel of any destination in the heart of our big cities.

There must be many millions of Americans who travel by streetcar, bus, railway and private automobile from 45 minutes to more than an hour twice daily to reach their places of work and a large portion of these do not even have the reward of open country at the end of the

line. It is a good certainty that great numbers of them are going to embrace the helicopter as a welcome means of reducing the time to 15, 20 or 25 minutes each way.

Latest figures released by the U. S. Census Bureau show that 53.4 percent of Americans live in cities and their suburbs and of course the preponderance of city dwellers continues to increase. This trend is the result not necessarily of any desire on the part of American citizens to live close together in congested areas, but is rather because modern business and industry can more proficiently and expeditiously be conducted through large, centralized, co-ordinated units. The wholesale congregation of residences around centers of commerce and industry is largely an indication that most people prefer to spend a minimum amount of time in routine and frequently uncomfortable travel between home and work.

The helicopter, along with other forms of aircraft and improved means of surface transportation, will very likely start to diminish, and in years to come even turn back, the trend toward urban dwelling. That this factor of decentralization of residences will be of supreme importance in the future happiness and welfare of American people, few will deny. For wherever there is overcrowding and acute congestion of people in cities and towns, there is filth, disease, crime and excess of human misery.

It is not meant to imply that complex causes and effects of social and economic ills can be reduced to simple

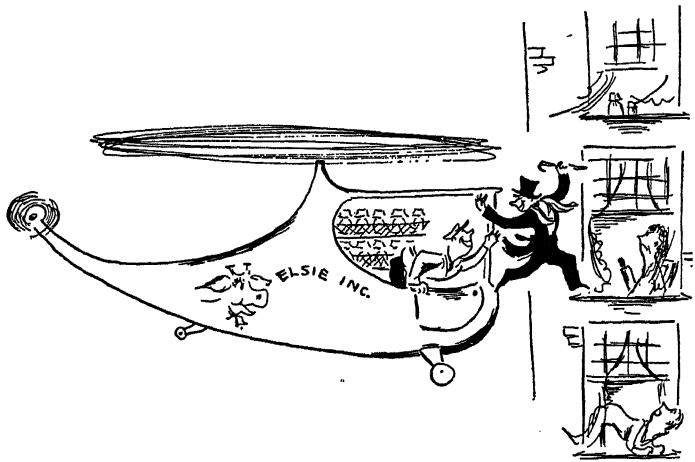
terms and cured by swifter transportation. But it is maintained that the availability of such transportation on a wide scale can make an important contribution toward the desired improvement in ways of living. For example, is it not entirely reasonable to assume that the suburban areas of our present-day large cities would not be nearly so spacious and widely distributed if it were not for the automobile and the relative indifference to a few miles, more or less, which it brings to the car owner?

Now for the helicopter versus the automobile—really a poor way of stating the subject, because it implies a conflict between the two vehicles where there should be none. The helicopter will not replace the automobile. However, the helicopter not only will do many things the auto never could and never will do, but will also do many things that the automobile now does, only very much better.

Many persons not acquainted with the rather novel performance characteristics of the helicopter do not regard as practical the idea of jumping into a helicopter to flit down to the drugstore for some ice cream on a hot summer night. While this would be impractical in many existing congested communities, it by no means follows that the same would be true in the towns and suburbs of tomorrow.

It is going to be simpler, less fatiguing and more pleasant for housewives of the future to ascend from their

lawns and do their daily shopping within a radius of five miles, say, with less than five minutes elapsed time each way, than it would be to get into an automobile, back down the drive to the street and negotiate intersections,



winding roads, traffic signals and so on within a tenth of the distance.

The helicopter is such a simple, easily controlled craft that if it were desired to go round the corner and pick up Mrs. Jones it would be easier to fly the distance than to taxi or roll along the surface. In these days we think of tanks and jeeps and half-tracks as being able to negotiate impassable terrain and overcome almost all natural obstacles. But the helicopter is far more versatile than any other vehicle yet devised by mechanical genius. It

can land not only on dry earth, but on water, snow, ice, marsh land or shifting sand. If it cannot actually land, as in areas of dense jungle or sharp, jagged rocks, the helicopter need only stop in mid-air a dozen feet above the trees or rocks and set down or pick up passengers or cargo by means of a rope ladder.

Normal helicopter landings are made so gently that there is hardly a perceptible jolt. As a matter of fact, a test was made with a Sikorsky helicopter in which a dozen eggs were suspended in a net beneath the cabin. Examined after landing, not an egg was cracked.

With respect to landings on water and swamp lands, these have been made in the past with helicopters especially equipped with inflated rubber floats. With these rubber bag floats, of course, it was still possible to land on solid earth, but the helicopter so equipped could not be rolled or taxied on solid ground.

A truly amphibious helicopter, therefore, would have a hull or floats for landing on water plus retractable wheels for land operation. It is not likely that amphibian helicopters will be the rule because of the weight penalty. In other words no matter how well an amphibian vehicle of any kind is designed, it suffers impaired efficiency because of the extra weight and equipment needed to enjoy the dual advantages. Undoubtedly, however, such amphibian helicopters will be available to those who desire the more versatile craft and can afford the consequent increased cost. The conventional

helicopter with wheels for taxiing along the ground can readily be equipped with automatic flotation gear for protection in the event of emergency water landings, without the cost and weight penalty being prohibitive.

In spite of all the technical and popular articles published proposing highway vehicles which would operate on water as well, nothing of this kind was ever developed and marketed. Why? Simply because on land it would be less comfortable and efficient and more expensive to operate than an equivalent automobile designed primarily to operate over highways, and on water it would be less seaworthy and more expensive to operate than a comparable boat.

But it should be noted that such a vehicle was not at all impossible or even unfeasible, for as soon as the exigencies of modern warfare made such vehicles desirable they were engineered and manufactured in great variety and quantity. In the present war there are amphibious jeeps, tanks, landing boats and other vehicles. Considerations of relative economy and efficiency are dismissed in the face of necessity.

The coming of the helicopter will open up entire new areas for recreation and, in time, for residence and farming. Mountain lakes, forests and other spots of great natural beauty hitherto inaccessible except at prohibitive cost in time and money will become back yard paradises for helicopter owners.

Rural life in America, particularly for the farmers, will be revolutionized by the combined influence of the helicopter and the light plane. The farmer will use his helicopter to carry perishable products to more distant markets. He will use it to pick up seed, emergency supplies, repair parts for farm machinery and so on. With it, he can spray his fruit trees, sow some of his crops and hop up to the state fair. In a surprisingly few years, helicopters and other aircraft will insinuate their way into the social life of farms and ranches; rural and urban America will grow less and less distinguishable, and better understanding of each other's problems and ultimate community of interest will result.

Even before World War II quite a few farmers in the West owned their own planes and were finding practical uses for them. With the helicopter eliminating the need for specially prepared landing places anywhere outside of cities, and with the less training and skill required for their safe operation, there is just a possibility that all the "dope" will be upset and that the farm population will prove to be the first "mass" market for private aircraft.

The helicopter is going to be God's own gift to the ranchers. Far more versatile than the horse, it will "ride" hundreds of miles of range a day, its cowhand-pilot inspecting fences, stopping to make repairs whenever necessary, spotting the most verdant pasture lands from higher altitudes, perhaps even riding herd on cattle with the aid of a megaphone in the cabin. Calves and lambs

suffering from minor but disabling ailments can be quickly transported to the ranch house for veterinary treatment. Savings from this source alone might pay for a helicopter within a year in the case of herds of any considerable size. Cattle stranded by sudden floods or blizzards can be more readily located, then easily fed for days or weeks. With a helicopter of suitable size, cattle could be transported one by one to a place of safety.

Even on the part of those who are willing to grant that the helicopter will be a handy thing to own in Helipark or down on the farm, it may well be asked, "Of what use is your helicopter going to be to you when you fly to New York, Atlanta, Kalamazoo, or Reno?"

Let's begin with New York, since it represents on the whole the most thickly populated area in the United States, with stupendous traffic and transportation problems. Manhattan Island is thirteen miles long and averages only a couple of miles in width. All traffic entering and leaving the city must travel by ferry boat, under-river tunnels or bridges. These means of ingress and egress are necessarily limited in number by economic and geographical considerations. Each one constitutes a bottleneck in its particular area during peak traffic conditions, as any metropolitan commuter will testify.

New York, like many another great American city, arrived at maturity long before the airplane was recognized as a legitimate means of transportation. Hence,

over the entire island, scarcely any level area sufficient to provide a modern airport remains, even if it were considered safe to land and take off airplanes in the vicinity of Manhattan's skyscrapers.

Suppose many thousands, say, a hundred thousand helicopters, converge on Manhattan from all directions to land within a given hour. Suppose further that heliports have sprung up all around the shore line of the island to handle this traffic. We will assume arbitrarily that an average one can handle ten landings simultaneously. Allowing a full minute for the landing and clearance of each landing area, such a heliport would have a capacity of 600 helicopter landings per hour. Only 166 such heliports would be required around the perimeter of the island, or a few to each mile of shore line.

Such heliports could be designed as new structures with flat roofs and storage space on floors beneath. It is also very probable that dock buildings and warehouses could be provided with new roofs and converted for such use. In addition, open areas on level ground could be utilized for landing and open-air storage, as in the case of outdoor parking lots for automobiles.

Furthermore, there are in New York, as in nearly all large cities, great slum areas where structural decay and property depreciation bring ever-diminishing returns on real estate investments and where an enterprising businessman may one day find it is more profitable to raze the tenements after obtaining approval from necessary

authorities for construction of heliports. Such a project would immediately improve an area and attract shops, offices and plants to the neighborhood.

Oh, yes, the traffic problem! Well, it would not be serious at all. I will try to explain why. In the first place, the hundred thousand helicopters converging on Manhattan would not be flying helter-skelter and willy-nilly. Each craft would be approaching on a well-defined aerial highway at a specified altitude and speed over a clearly marked geographical surface area.

"Well," someone asks, "will this not create traffic bottlenecks just like the tunnels and the bridges?" No, because there is no practical limit to the number of such highways which can be created and designated.

Imagine yourself in the worst highway traffic jam you have ever experienced. Then add duplicate highways above the ground level at 100-foot intervals until you have ten highways. If this does not completely eliminate traffic jams, simply add five more tiers of highways at 100-foot intervals to your left and five more at 100-foot intervals to your right. A little lightning calculation tells you that you now have 110 times the highway capacity that exists in reality.

There is no traffic congestion in the air. Congestion in air traffic occurs only when large numbers are descending to the ground or leaving it within a limited area. When civil aircraft, commercial or private, are involved in aerial collisions it is only because some pilot

was guilty of flagrant violation of air traffic rules. It is not unreasonable to assume that all helicopters operating in metropolitan areas will necessarily be equipped with radio receiving sets for the purpose of receiving instructions from air traffic control stations along the airways they travel.

Thus, necessary facilities will arise and grow in number as the need for them increases. Some cities, wisely seeing the shape of things to come, will plan beautifully landscaped parks and recreation areas close to business districts. Small plots will be marked off for heliports and under the sod spacious subterranean garages will be provided for the parking of helicopters and autos.

Chicago, for example, could conveniently develop a system of heliports and shallow underground parking places along the lake front between Michigan Avenue and the shore. Residents of other cities will immediately recognize similar possibilities with respect to their own metropolitan areas.

The Mall, extending from the Capitol to the Lincoln Memorial in Washington, is adjacent to government buildings housing many thousands of federal employees. A series of small heliports and large underground parking areas would greatly relieve the severe traffic and housing congestion which existed there even before World War II aggravated conditions to the present extreme. Moreover, the serene beauty of such parks would not be marred in the slightest.

CHAPTER IX

RECONVERSION AND POSTWAR PROBLEMS

THE aviation industry in 1939, when World War II started, was forty-fourth in dollar volume of all United States industrial activities. Today it is first. Yes, in four short years, that puny little upstart in the transportation business doubled and redoubled so many times that by 1943 it had achieved the distinction of being our number one industry, both from the standpoint of dollar volume of goods produced and the total number of workers employed.

While it is true that this phenomenal growth was the result of war, it should not be lightly assumed that this great volume of production never would have been achieved if it were not for the war. It would have taken a longer time, that is the only difference.

Wartime economy is a cockeyed reversal of everything we preached and practiced in peacetime. Whereas in normal times every business activity must "pay its way" and eventually show a profit if it is to survive and continue, winning a war requires getting there "fustest with the mostest," to paraphrase a famous Civil War

general, and it does not matter a hang whether the transportation of needed men and materials to the strategic front costs two cents or two hundred dollars per ton-mile.

In the latter connection a few comparative figures on the relative speed of air and surface transportation are enlightening. The trip from San Francisco to Australia requires 28 days by ship, but the transport plane gets there in 73 hours. In comparison with 3½ days from coast to coast by train, air transport makes it in 18 hours. The sea trip from New York to the port of Basra on the Persian Gulf takes 42 days through the Mediterranean and Red Sea and 70 days around the southern tip of Africa and up through the Indian Ocean. By air the entire trip requires approximately 100 hours or just a trifle over 4 days. Furthermore the figures given here are based on actual schedules in operation over military routes rather than on the best possible time under ideal conditions.

In effect, what is happening is this: The airplane by virtue of its speed and versatility is being handsomely subsidized, to use the word in a very restricted sense, in relation to other forms of transportation. No one in his right mind, of course, will begrudge this windfall to the progress of aeronautics and the advancement of the aviation industry, for it happens to be the most essential ingredient in the formula for survival and victory. Nevertheless, it cannot be denied that this pouring in of mil-

lions of dollars and the energies of literally millions of men and women has brought this 20th Century upstart to a technological and commercial maturity at this time, which it might not otherwise have achieved for a decade or longer.

With the coming of peace, a great many leaders of government and business are going to try to turn back the clock of progress. They will hold, and with plausible arguments I am sure, that this temporary advantage gained by aviation, particularly air transportation, in war, is unjustly discriminatory to older established forms of transportation and that we should immediately go back to the good old economical way of moving goods and persons.

What many such men will fail to realize is that the vastly expanded utilization of the airplane has decreased the cost of manufacture and increased performance, safety, and over-all conditions of operation to a point where operating costs per ton-mile are only a fraction of what they were at the start of the war, and that hence air transportation will immediately be able to take a slice of the domestic traffic pie perhaps twenty times greater than the prewar volume, in direct economic competition with other forms of transportation.

The role of air transport in international commerce probably will be even more important, for there again the airplane enjoys such unique advantages in relation

to time, that many services can be performed at cost plus profit without competition of any kind.

United States and world air transport will be doing a far greater volume of business the week after peace is declared than it was doing when World War II began. Furthermore, it will continue to grow by leaps and bounds year after year on a scale undreamed of by men unacquainted with the unfolding potentialities of aviation.

The government in 1943 owned more than five hundred plants engaged in aviation production, which were constructed at a total cost of nearly three billion dollars. This was approximately ten times the value of privately owned investments in the industry. The same thing held true on a diminishing scale in many other industries. In the face of factors like these and with the prospect of wholesale cancellation of contracts when the war ends, there will be a tendency on the part of many corporations and business owners to tally up the profits, pay off the shareholders and close the books—and the factory doors. That is precisely the surest and the quickest method which could be devised to achieve an eventual national economic disaster which would make the depression of the early thirties seem like a golden age by comparison.

This may seem to be wandering astray from the helicopter, but it is not. The helicopter not only is going to affect your everyday life and happiness, but it is go-

ing to play an important role in your national economy as well. It is extremely vital that every possible business now engaged in war production remain in business and maintain maximum possible production of goods for the civilian market.

Hence, since aviation is now our largest single industry, its leadership, its example, and the resultant influence on other industries and even on the national psychology, can conceivably swing the balance towards orderly, optimistic reconversion of industry to peace, away from fear and industrial chaos.

Naturally we do not want to, nor could we, go on producing 100,000 airplanes a year like those now being built to prosecute the war.

In 1939 there were actually only 265 aircraft engaged in providing our domestic scheduled air transport services. We do not yet know enough about the types and tonnages of aircraft that will supply scheduled air service after the war to make realistic numerical estimates. But the following calculations will serve very adequately to illustrate a point.

Assume a very optimistic tenfold expansion and add 50 percent for U. S. airlines engaged in foreign services. That makes 3975, or less than two weeks' production at the current rate, and these planes would be so good that they would not need replacement for many years to come.

It will be sheerest folly if our nation does not main-

tain a large and efficient air force through the unsettled years following the war as the cheapest form of national insurance against another war. But even an adequate procurement program for this purpose would require only a small fraction of the industry's production capacity. Add to this what probably will be considerable sales to foreign governments and airline operators. The picture remains dark. The greater portion of the industry still would have to fold its checkbooks and release hundreds of thousands of employees to compete with the returning soldiers for bread and butter and a place under the sun.

Let us turn from this dismal prospect to consider the closest historical parallel, the expansion of the automotive industry following World War I. In its best year, 1939, the automotive industry did several billion dollars' worth of business and turned out 5,358,420 units. Trucks, buses and other commercial vehicles accounted for only 771,020 units, or 14.4 percent of the total. The backbone of that great industry has always been the mass consumer market.

Of the 100,000 planes currently produced yearly by the aviation industry, the majority are multiengined, many of tremendous size and all of great complexity. If the equivalent materials and man-hours were devoted to the production of private-owner types, the 100,000 figure would be multiplied many times over.

So we come to the crux of the matter. If we hope to

maintain a substantial proportion of the business activity and employment represented by the wartime aviation industry, a consumer demand for several hundred thousand suitable private-owner types of aircraft must be developed and supplied as quickly as is humanly possible.

Total war production was estimated at 63 billion dollars for 1943 and is scheduled to reach 80 billion dollars in 1944. The aviation industry, comprising over 50 percent of the total, becomes far and away the greatest single factor in the American industrial picture. Therefore, the extent of its collapse or success in reconverting promptly to production of peacetime products in considerable volume will be a tremendously important factor in determining whether the national economy drops in a sharp downward spiral or succeeds in maintaining a steady course.

Top leaders in the automotive industry estimate that six months will be required following the ending of hostilities before volume production of automobiles and trucks gets under way. Of course, much will depend on whether the war ends abruptly or dwindles slowly to a final termination.

If this is true of the automotive industry, which stoutly holds that the postwar car models will be the 1942 models, the aviation industry in most instances must look to a far longer period. The reasons are many and varied. First, there will be no 1942 models to go back to. Advances in every phase of aeronautics have

been so great during the war that almost any 1942 product will be too obsolete to bother with. Next, as this war proved so conclusively, aeronautical development and engineering is a far more lengthy and difficult process than automotive engineering. Too, the 1942 automobile was a marvelous machine and the average American citizen got more pleasure and profit out of the money invested in his automobile than in any other product. But it must be remembered that, when compared with the lowliest aircraft engine or instrument, the automobile from a technical standpoint is a crude mechanism—like the difference between a fine precision chronometer and a cheap alarm clock.

For another thing, the automotive industry has thousands upon thousands of machine tools of its own plus many more thousands owned by the Government which probably will be made available to the industry at fairly low prices. Most of these will be adaptable to automotive production. On the other hand, the machine tools possessed by the aviation industry, largely owned by the Government, are suited only to military products and in very few instances would be suited to production of a consumer aviation product. In other words, the automotive industry will be tooled up in short order, but the aircraft industry will have to start from scratch, except for limited production of military types and large transport aircraft.

Obviously it will be suicidal from the standpoint of

our national welfare if no provision is made to ease this multibillion-dollar activity down to its normal economic level by easy stages. Economy-minded Congressmen who call for abrupt cancellation of contracts immediately upon termination of hostilities may save American taxpayers a few million dollars in 1944 or 1945. But the resultant economic and social carnage might well deal our nation a reeling blow from which it would take decades to recover. The latter course would cost many times as much in dollars *plus* a toll in human misery too frightful to contemplate.

Other industries and essential groups of business interests will raise the cry of subsidy, forgetting that their industry or activity in all probability got its initial impetus through some form of Government subsidy or assistance.

The country's leading automotive executive was saying recently that he and his associates always took pride in the fact that the automotive industry had grown and prospered without subsidy or outside assistance. I innocently asked, "What about our public roads system?"

Glibly and quickly he replied: "Oh, that is more than taken care of by taxes on gasoline."

He overlooked two important factors in that ready answer. First, the nation's highway users repaid to the Government its billions of dollars invested in our highway system only long years after the Government made the initial investment. The industry could never have

reached its present proportions without that handsome assistance in its early years. Second, a big air transport or bomber burns in one hour enough gasoline to operate a private car for a year. The gasoline is of a higher grade which costs much more and consequently the taxes are greater. A score of years from now the national purse will be handsomely repaid for any investment it has made or makes in the future to encourage and aid the development of commercial and private air transportation.

In his enthusiasm over the beautiful backlog of business awaiting him as soon as peace comes, the manufacturer of automobiles and many another consumer product blithely overlooks the fact that a few years from now hundreds of thousands of well-paid young workers in a growing and prosperous aviation industry can provide a much longer and steadier market for his product than the customers who flock to him with their savings immediately after the war.

The financial problems facing the aircraft industry are unparalleled in history. The Government's tremendous demand for aviation products plus its ownership of such a large portion of the industry's plant facilities and inventory, coupled with taxation and limitation on profits, leaves precariously little working capital for most aircraft companies.

Corporate resources of many companies may prove

inadequate to absorb losses resulting from contract termination and inventory liquidation.

Costs of contraction and conversion may consume most or all of available funds, so that remaining capital together with what additional capital might be raised may be inadequate for the maintenance of peacetime employment and production.

Average working capital of the industry in 1943 was just about sufficient to meet expenses for payrolls and materials at the then current rates for about two weeks. In most instances many months will be required for the accounting and negotiation involved in settlement of contracts, plus retooling, engineering experimentation and development, testing new models, and so on. The financial problem involved in bridging this gap so that the very real potential for employment and prosperous commerce will not be lost to the nation is a very grave one.

To assist in meeting this problem two things are desperately needed. First, modification or amendment of existing laws and regulations to enable aircraft companies to build up legitimate reserves for postwar reconversion, and second, establishment through co-operation between Government and industry, of definite procedures for prompt termination of war contracts on terms which will not hamstring the industry in efforts to reconvert to peacetime production.

Although many industry leaders argue that the Gov-

ernment must take the initiative in establishing policies to meet these problems, it is strongly suspected that the industry and the nation ulimately will fare better if the aircraft builders themselves get together promptly and evolve a definite program for presentation to the Government.

A constructive step in this direction was taken by the Board of Governors of the Aeronautical Chamber of Commerce of America at a meeting held in the fall of 1943, which approved a series of recommendations covering contract renegotiation and termination, use and disposition of surplus aircraft and plant facilities, and export policies.

Vigorous follow-up of the recommendations which were drawn up and approved will go far toward meeting the grave problem facing the industry, provided adequate co-operation can be enlisted from various agencies of the Government which are involved.

A majority of leaders in Government and industry have been reluctant to discuss postwar problems or plans for meeting these problems in an orderly manner. This usually was justified on the grounds that the major obligation was to win the war first. Too often, however, there has been a sincere recognition of the need for postwar planning, but a refusal to act on the conviction because of fear of criticism or reprisals.

On the other hand, the victory we as a nation are striving so hard to achieve will prove a hollow mockery

if this nation, along with the greater portion of the civilized world, falls into economic ruin and subsequent political chaos through failure to devote a small fraction of our energies to the problem of reconverting our civilization to peace while still straining to win the war.

One thing is sure: if economic, political and industrial leadership does not prepare adequately and actually succeed in averting mass unemployment of disastrous proportions, the system of free enterprise and individual liberty which the great majority of Americans cherish so dearly will inevitably give way to a new framework of government and an economy which is rather likely to be less pleasant and prosperous.

Of course employers do not make jobs. Customers make jobs; they buy goods, factories operate to produce them, workers are employed in the plant to meet the demand, and so on.

So the objective is not to subsidize or assist any particular industry, or all industries, in the hope that mere production of goods will maintain employment and prosperity. The objective is rather to establish the framework now which will ensure for all industries a reasonable opportunity to meet existing or potential consumer demands without being forced into bankruptcy or having to close down plants and production facilities on a wide scale.

War is a costly business and all of the plants which have been built in recent years to produce munitions

cannot be expected to convert to peacetime products and commercial operation during the immediate years ahead. The war is going to continue costing us, as a nation and individuals, for a long, long time to come. We can conceivably meet it without economic ruin if we are successful in maintaining production, employment and purchasing power on a scale comparable to prewar activities, with the prospect of sound expansion from there on. But there is not the remotest possibility of our surviving the burden of war's expense if half of our economic resources and production facilities fall idle while millions of people are unemployed and underfed.

To sum up the importance of the helicopter progress and aviation's development generally in this picture, consider these facts. Several million men will return from the U. S. air forces, where they are serving as pilots or technicians, to civilian life. Many of them will have breakfasted in England and dined in New York the same night. Thousands of them will return to civilian life having flown more hours in the air than they ever spent in automobiles or railroad trains. There is no possible way of determining exactly how many, but certainly hundreds of thousands of these men who have participated in flying for so long are now "sold" on flying as the quickest and pleasantest way of getting where they want to go for the rest of their lives.

In the surface forces of the Army and Navy, men have watched their comrades in the sky with envious

yearning and know full well that the time is not far distant when they can fly their own aerial flivvers if they so desire—while at home, still more millions during every single day of their lives since long before Pearl Harbor have heard over the radio and read in their newspapers and magazines the undeniable evidence that the air age is upon us—not coming or "just around the corner."

If this does not now constitute one of the nation's most promising new potential markets for goods and services, what does?

The helicopter can without a doubt become as safe as any other means of transportation in the history of the world—but only if manufacturers of the vehicle will recognize an obligation to sell a philosophy of safety along with a mechanically safe product.

Truly farsighted manufacturers and promoters of the helicopter will not only tell the public what their helicopters will do in the way of performance, but will also tell the buyers what their helicopters cannot do safely. To know the limitations of an instrument is fully as important as knowing its capacities. The wise helicopter manufacturer will want his product associated with safe and dependable flying.

No matter how perfectly a helicopter is designed and how beautifully it is built, an instant's thoughtlessness at the wrong moment or gross neglect of its mechanical needs can turn it into an instrument of death for its

occupants and others. No advantage will be gained by sellers of helicopters who attempt to gloss over this fact.

It is to be hoped that aircraft manufacturers will take a lesson from the neglect of emphasis on safety in highway transportation to inaugurate new concepts of the vendor's obligation to promote the safety of life and limb of the buyer of his product—not alone through mechanical perfection of the vehicle, but by appropriate efforts to instill in the buyer strong habits of safe operation and maintenance as well.

This is no altruistic proposal. Hard-headed businessmen with imagination immediately will recognize the practical value of an intensive safety program. If, for example, during the rush to exploit the helicopter market insufficient attention were given to safety considerations and a series of tragic accidents occurred, it would have the result of setting back helicopter sales by millions of dollars a year.

Enterprising manufacturers might very well consider the wisdom of keeping close tabs on each of its helicopters from the time it leaves the factory doors until it is traded in on a new model or junked. Coupled with this close mechanical watch over helicopters in service would be a program of continuous safety education aimed at the owners through some interesting and inoffensive medium. The reputation of all helicopters for safety and reliability will be so important that all manufacturers might well co-operate in setting up standard-

ized procedures for inspection and repair, even helping to insure the operating and mechanical safety of each other's products.

In this latter respect, the airlines have shown the way toward better business and improved public service by recognizing that the safety record of each airline determined the safety record of the industry as a whole. To achieve the highest possible safety standards, the air transport operators have for years pooled all their safety knowledge and freely exchanged complete information on technical developments wherever a safety factor was involved; even though it might in some instances mean the loss of a competitive advantage.

Time has tested and proved the extreme worth of this co-operative venture within the framework of economic competition, for perhaps no other industry in history has grown so rapidly and at the same time earned world-wide public confidence and acceptance.

There is another extremely important implication in a co-operative safety program of private aircraft manufacturers which should not be overlooked. Safe, intelligent operation of private aircraft will do more than any other one thing to discourage restrictive regulation.

One danger which must be faced squarely by Government and industry both is the possibility of excessive or unwise regulation, Federal and local, artificially restricting the expansion of private flying.

The best way to eliminate any regulation is to demon-

strate the lack of any reason for its existence. The United States Government through the Civil Aeronautics Administration, the Civil Aeronautics Board and other Federal agencies, wields enormous powers over every phase of the flying business, from the activities of private citizens in their own aircraft to the financial operations of great corporations.

These agencies have in years past been responsible for much wise regulation and enthusiastic assistance and encouragement to aviation. However, with the extraordinary powers exercised by certain of these agencies over purely technical matters, dangerous tendencies have manifested themselves in the failure to properly distinguish between safety and economic regulation on the one hand, and design progress and technical advancement on the other.

Any failures of the Federal agencies in the latter respect have not been due to deliberate intent or political machinations, but rather to the inherent tendencies of bureaucratic organizations to preserve the *status quo* until overwhelmingly convincing evidence is presented demonstrating a need for change. This is not even necessarily a defect, for it is expecting more than is fairly warranted to demand that the creative processes which lead to change within an industry take place in a regulatory agency simultaneously with the original developments in the laboratories and factories.

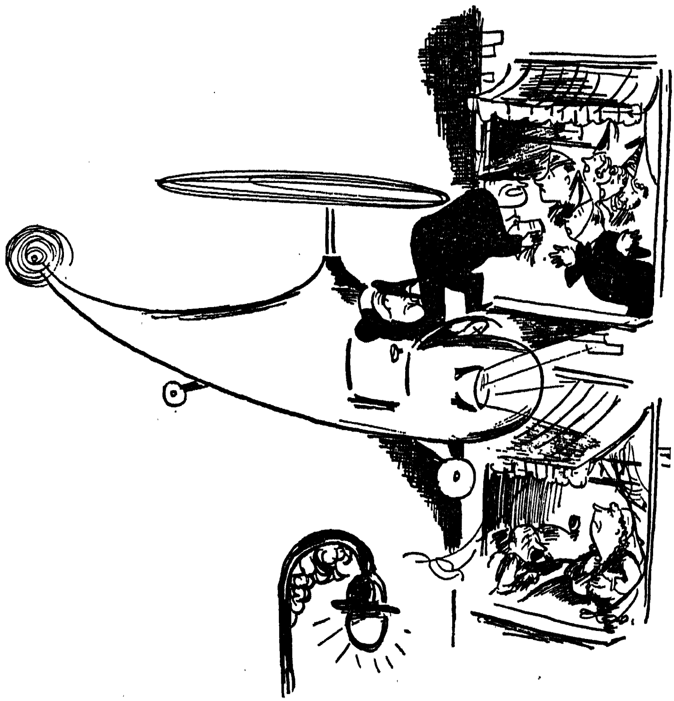
The answer is obvious. The aviation business con-

stantly must hold the initiative and make every effort to insure that its spokesmen will be articulate and convincing. Quibbling, in the form of mere complaint and politically tainted criticism, is not enough—nor is it even the right approach. Appropriate action in the first instance, followed up by facts and evidence convincingly arranged and presented to the proper persons at the right time, will achieve for the aviation industry in Washington whatever legitimate goals it may aspire to.

The aviation industry also must work closely and understandingly with state and local governments. Admirable progress in this direction already has been made by the air transport industry. Airline traffic representatives are sincere and capable boosters of the communities which their organizations serve and they lose no opportunity to demonstrate to leaders and public alike how increased utilization of air transportation can contribute to the growth and prosperity of their community.

Now is the time for private aircraft manufacturers to co-operate in seeking the establishment of safe minimum requirements for licensing and operating regulations for all types of private aircraft and to work untiringly for adoption of uniform requirements throughout the length and breadth of the land. For confusing and contradictory laws and regulations can seriously restrict the utility and pleasure of aircraft operation between cities and states enforcing conflicting rules.

Much work along the lines advocated has been carried out by various worthy organizations. Their efforts have been well expended and their pioneering all was to the



good. But now the same projects must be conducted on a scale impossible of accomplishment heretofore.

When the aircraft industry, on behalf of the nation's private flyers, proves conclusively, consistently and persistently that a citizen need not be a graduate meteorolo-

gist, an air navigation expert or know any more about his aircraft engine than the average motorist knows about his ignition system in order to fly safely and sanely in interstate commerce, we can rest assured that such hindrances to the maximum utilization of private aircraft will be forthwith abolished.

The entire flying fraternity—maker, middleman and user alike—will benefit by accepting at the outset the proposition that flying must be subject to stricter regulation than motoring. Stricter regulation does not mean more restrictive regulation. It is merely that in peace as in war the aerial vehicle possesses more destructive potentialities than its earthbound counterpart. We know full well the damage which can be brought by automobiles out of control; still they cannot drop amidst the spectators in a crowded stadium, crash through the roof of a school or dwelling, or land in a gas storage tank and start a million-dollar fire.

Strict uniform regulations for private flyers, wisely promulgated and enforced, will in the long run lead to greater liberty, freedom of action and carefree pleasure for the users of helicopters and other private aircraft.

ADDENDA TO CHAPTER IV

Among most recently announced designs is Bell Aircraft Corporation's helicopter. The design is one evolved after years of research and reflects a keen awareness of the importance of stability in rotary wing aircraft.

This design incorporates a stabilizing device which Arthur M. Young had been developing in scale models for more than twelve years prior to his association with Bell Aircraft in 1941. His work resulted in a design which has been applied to machines developed by Bell Aircraft and flight tested in 1943.

The rotor of the Bell helicopter differs from the conventional, or Cierva type, rotor in that its position in space is governed not by the position of the mast to which it is attached but by an artificial horizon to which it is coupled, with the fuselage suspended beneath it much like a plumb bob.

In other words, the revolving rotor tends to remain horizontal and does not tip if the cabin of the plane encounters gusts of wind. This greatly increases the stability of the craft and tends to make it ride more smoothly. It also holds promise of greater ease of control.

The two-blade main rotor makes for a simplified hub design as well as offering certain aerodynamic advantages. The Bell helicopters have a single main rotor, with a conventional anti-torque propeller on the tail.

In the current models power is supplied by a 130-horsepower Franklin engine of a six-cylinder horizontally opposed type. It is mounted vertically and located directly behind the pilot's compartment. The transmission is mounted integrally with the engine, making engine, transmission, mast and rotor a single unit. The two-blade rotor with the unit arrangement described is a unique approach to the vibration problem.

In the fuselage the engine rests on rubber mounts of the conventional aircraft type. Many of the excessive vibrations encountered in operation of rotary wing aircraft are absorbed by this method of mounting.

Bell Aircraft Corporation believes that the helicopter has a very real future and that its own helicopters, while being developed now for their expected military value, will have many important peacetime uses, both for commercial and private purposes.

APPENDIX

Organizations Engaged in Manufacture or Development of Helicopters

Adel Precision Products, Burbank, Calif.

Aeronautical Products Inc., 18100 Ryan Rd., Detroit 12, Mich.

Aircooled Motors Corp. (Franklin Engines), Liverpool Rd., Syracuse, N. Y.

Air Cruisers, Inc., 330 Highland Ave., Clifton, N. J.

Airex Manufacturing Co., 5-33 48th Ave., Long Island City, N. Y.

All American Aircraft Products, Inc., 1350 E. Anaheim St., Long Beach 4, Calif.

Andrews Laboratories, E. F., 4367 Oakenwald Ave., Chicago, Ill.

Avery, Harold, 1129 Mandana Blvd., Oakland, Calif.

Aviation Engineering, Inc., 1390 Blashfield St., S.E., Atlanta, Ga.

Bell Aircraft Corp., 2050 Elmwood Ave., Buffalo, N. Y.

Blount, Earl E., 445 Debaliriere Ave., St. Louis, Mo.

Clark Electronics & Aviation Corp., 699 Madison Ave., New York, N. Y.

Cook, D. A., 2125 Lakeshore Ave., Los Angeles 26, Calif.

Detroit Gear Aircraft Parts Div., Borg-Warner Corp., Detroit, Mich.

Engineering Development Associates, 4310 Degnan Blvd., Los Angeles, Calif.

Fleetwings, Division of Kaiser Cargo, Inc., Bristol, Pa.

G & A Aircraft, Inc., Subsidiary of Firestore Tire & Rubber Co., Willow Grove, Pa.

Helicopter Corporation of America, 36 W. 44th St., New York 18, N. Y.

Helicopters, Inc., 50 Rockefeller Plaza, New York 20, N. Y.

Higgins Rotorplane, Higgins Industries, Inc., New Orleans, La.

Kellet Aircraft Corp., 58th & Grays Ave., Philadelphia, Pa.

Landgraf, Fred, 2123 W. 79th St., Los Angeles, Calif.

Machine & Tool Designing Co., 200 Madison Ave., New York 16, N. Y.

Mainline Trailer Coach Co., 8825 Avalon Blvd., Los Angeles, Calif.

Marine-Air Research Corp., 215 Main St., Annapolis, Md.

McCulloch Aviation, Milwaukee, Wis.

Nash-Kelvinator Corp., Lansing, Mich.

National Advisory Committee for Aeronautics (Research), Washington, D. C.

National Bent Steel Corp., 5307 Metropolitan Ave., Brooklyn, N. Y.

Pennsylvania Aircraft Syndicate, Wilford Bldg., Philadelphia, Pa.

Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

Platt-LePage Aircraft Co., Eddystone, Pa.

P-V Engineering Forum (Frank Piasecki), Ridge Ave. at Fairthorn, Philadelphia, Pa.

R. T. Machine Shop, 1207 E. Florence Ave., Los Angeles 1, Calif.

Reynolds Metals Co., Louisville, Ky.

RotaWings, Inc., 1011 Chestnut St., Philadelphia, Pa.

Roteron Co., 2514 Sunset Blvd., Los Angeles, Calif.

Rotoplane Corp., North Hollywood, Calif.

Sikorsky Aircraft Division, United Aircraft Corp., Bridgeport, Conn.

Stout Research Division, Consolidated Vultee Aircraft Corp., Dearborn, Mich.

Timm Aircraft Corp., Van Nuys, Calif.

Traverse Bay Mfg. Co., Traverse City, Mich.

Twin Coach Co., 850 W. Main St., Kent, Ohio.

Ziebarth, Fritz, Co., San Bernardino, Calif.